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(DEPTT. OF AGRICULTURE)

REPORT
OF
THE MINOR IRRIGATION COMMITTEE, 1957

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CHAPTER I

INTRODUCTORY

In its Resolution No. F.9-5/55-IRN, dated 12th July, 1955 (Appendix I), the Government of India, Ministry of Food & Agriculture had appointed an Expert Committee to study the work done in the field of Minor Irrigation and thereafter assess future possibilities and indicate steps that need be taken by the States to make the minor irrigation schemes more effective in the irrigation expansion of the country. The Committee comprised of Shri Mahavir Prasad, Irrigation Adviser, Ministry of Food & Agriculture, Shri S. R. Vasudev, Director (WIN) Central Water & Power Commission of the Ministry of Irrigation & Power, and a representative (preferably Chief Engineer) of the State concerned. The names of State representatives are listed at Appendix II. In addition, Shri D. S. Sinha, Adviser (Irrigation) of the Ministry of Community Development, was also co-opted.

A questionnaire seeking requisite information was sent to the States in September, 1955. A copy of the questionnaire is enclosed as Appendix III. In spite of repeated reminders, complete replies were not received to the questionnaire. Finally, the Committee had to visit the States and held discussions. A list of the officers with whom discussions took place is given in Appendix IV.

On the basis of data thus collected, the Committee has recorded its recommendations in Chapter II.

The Committee has further been able to examine certain States in detail. Individual reports on these States form Appendix V. These give information on the irrigation performance and deal with future prospects on minor irrigation. Separate recommendations are offered on technical issues and organisational arrangements.

CHAPTER II

RECOMMENDATIONS

SUMMARY OF RECOMMENDATIONS

On the 12th July, 1955, the Government of India, Ministry of Food & Agriculture, appointed an Expert Committee to study the work done in the field of minor irrigation and to assess future possibilities and indicate steps that may be taken to make the minor irrigation schemes more effective and fruitful. The main recommendations of the Committe are as follows:—

(1) *Surface water diversion*:

(i) For assured irrigation benefit, it is desirable that the minimum flow of the streams and its duration are invariably ascertained specially on streams that are flashy and whose discharge widely fluctuates. It is true that the age old practice of putting temporary embankments across the streams every year is now being replaced rapidly by pucca masonry constructions. The bunds should be satisfactorily completed to bring about lasting benefit from these works. With this end in view it would be desirable to study the use that the up-stream water is already being put to. Such a study may bring out the advantages of combining two or more weirs at one place. State Governments should also examine the existing alignments in the lay-out of the projected water distribution system as in the case of Sakhri and Kumri irrigation schemes in Bihar to explore the possibilities of an integrated lay-out.

(2) *Surface water storage*:

(ii) In the hilly and undulating regions, it is desirable to have small storage in order to avoid costly construction of water channels.

(iii) For an economic design of the storage schemes, basic hydrological data of flood discharge, minimum flow, co-efficients of yeild and run-off need be determined.

(iv) For storage that are proposed in relatively drier parts of the country, the water yield from single catchment will have to be increasingly supplemented by diversion of flow from adjoining catchments.

(3) *Chain system of tank irrigation*:

(v) The State of Madhya Pradesh and Orissa should examine the possibilities of setting up chain systems of tank irrigation as in vogue in parts of Bombay and Mysore, as it is important that adequate surplusing arrangements are provided so that if any tank breaches, the tanks situated lower down are saved.

(4) *Surplusing arrangement on tanks:*

(vi) Every tank should be designed for passing the flood discharge from the catchment. The flood discharge should be carefully computed so that an economic design for surplusing can be decided.

(vii) Ample capacity for flood surplusing need be provided on tanks that are constructed in the areas frequented by cyclones.

(5) *Evaporation losses on tanks:*

(viii) In arid regions it would be desirable to decide construction of tanks deep and lower area of water spread so that evaporation losses are minimised. It may be desirable to utilise the entire storage in rabi without attempting to carry over supplies to the following kharif.

(6) *Silting of tanks:*

(ix) In States where appreciable silting of tanks is observed, it would be desirable to provide initially for extra storage capacity.

(x) It may be advisable to discourage cultivation in tank beds and also take special care of the foreshore area in order to reduce the silting of tanks.

(xi) The restoration of a silted tank will be relatively cheap if tank banks are raised instead of desilting the bed.

(7) *Restoration of old tanks:*

(xii) It is important that proper standards are laid down for restoration of tanks with different irrigation capabilities.

(8) *Surface water lift irrigation:*

(xiii) At quite a few places, large pumping installations have been arranged at great cost without satisfactory arrangements for conveying rather large quantities of pumped water. It would be desirable to discourage large installations and thereby avoid over capitalisation. As an alternative, it would be desirable to attempt a large number of small installations.

(9) *Kuhls in hilly areas:*

(xiv) It is advisable to take care of the flow from all intervening drainage by providing suitable covers on the kuhls at suitable points.

(10) *Groundwater utilisation*:

(xv) It would be desirable for the States to organise their own exploration with whatever drilling equipment they have with them.

(11) *Construction of open masonry wells*:

(xvi) In the future construction of wells, care should be taken to see that the wells are not constructed too close and special steps taken to stop the retrogression in the nullahs.

(12) *Choice of Pump sets*:

(xvii) It is important that the performance of the pump set is estimated on the de-rated horse power instead of the usual figure that is meant for a few hours' running.

(13) *Filter Points*:

(xviii) Instead of driving the filter it is installed in a bore hole, the yield of water at the filter point would be improved.

(14) *Artesian Wells*:

(xix) Steps should be taken both by Madras and Andhra States to regulate the construction of artesian wells.

(15) *Tubewells*:

(xx) For successful running of tubewells an assured source of power must be arranged. Steps should also be taken for introducing a pattern for intensive cultivation so that the tubewells are kept running all the year round.

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(xxi) Paddy cultivation in tubewell command is not very congenial to successful tubewell running.

(16) *Improvement of water supplies on wells*:

(xxii) Cheapest manner of arranging new irrigation could be to tackle the existing wells for improved water supplies.

(17) *Power for water lifting*:

(xxiii) In the interest of lift irrigation, it is desirable that a definite allocation is made on all power schemes for use on agricultural pumping, at reasonable rates. Steps should also be taken to avoid wasteful installations so that electrical generation arrangement is put to maximum work. The Agricultural and Electrical Experts in the States should also scrutinise proposals before sanctioning finances for pumping set installations.

(18) *Water distribution channels*:

(xxiv) The water distribution system deserves as much attention as the main work. It would be desirable to leave the construction of small length channels to the beneficiaries as practiced in Mysore and Madras.

(19) *Spray Irrigation*:

(xxv) It may not be economically feasible for general use but it has its advantages when the water source is in limited quantity.

(20) *Bund construction*:

(xxvi) Large scale construction by the local cultivators could be organised on the lines done in Sholapur and Poona districts of Bombay State.

(21) *Steps for accelerated construction*:

(xxvii) Sanction for the construction and the funds for payment should reach the field officers well in advance of the slack season. It is also desirable to sanction works in any area after taking into account the available labour strength and their maximum turn-out during the slack months.

(22) *Popular Contribution*:

(xxviii) Government should initially make available the entire required outlay and recover the local people's contribution in instalments.

(23) *Sanction of Subsidy*:

(xxix) It has been possible in Bihar to encourage the construction of a large number of works with the limited finances made available to them. The State does not ask for finances for the loan part and merely offers payments of the subsidy portion either in one lot on the completion of the work or in phased payments on partial completion. Other States can follow this example.

(24) *Record of completed works*:

(xxx) All completed works should be brought on record.

(25) *Legislative enactments*:

(xxxi) The States of Madhya Pradesh, Madras, Andhra, Mysore, Kerala and Bombay have already passed Acts and the remaining States should consider legislation on their lines.

(26) *Finances for maintenance*:

(xxxii) In order to encourage maintenance, a levy on the entire irrigable area is imposed in the States of Mysore, Madhya Pradesh and Madras. The remaining States may also adopt a similar system.

(27) *Organisation for maintenance*:

(xxxiii) The States should recruit technical men with previous experience for looking after normal repairs and for special repairs the State PWD should take care. The maintenance responsibility of tanks with irrigation capability lower than 50 acres should be left to local organisations *e.g.*, Panchayats, Gaon Sabhas, etc.

(28) *Shortage of technical personnel*:

(xxxiv) Shortages could be partially met by recruitment of Surveyors as Overseers. Local people with talent could also be utilised as Surveyors.

(29) *Assessment of irrigation benefit*:

(xxxv) All States should arrange for random survey through an independent organisation like the Statistical Section at Bombay, Madras and Andhra for assessing the benefit.

In Madras and Andhra, the entire irrigable area is subject to a wet assessment. This is a good incentive for beneficiaries to take full advantage of the irrigation water. Other States, particularly Orissa, West Bengal and Bihar should examine the possibility of adopting this method.

(1) *Surface water diversion.*

A few completed diversion schemes have not fulfilled their irrigation targets because of insufficient water supplies being available at the end of the monsoon and towards the beginning of the cold weather. For assured irrigation benefit, it is desirable that the minimum flow of the streams and its duration should invariably be ascertained specially on streams that are flashy and whose discharge widely fluctuates.

At several places in Bihar and on bandharas in Bombay, there has been the age-old practice of putting temporary embankments across the streams every year. These embankments are washed away by the first floods in the following monsoon. Quite a large number of these embankments are being rapidly replaced by pucca mansonry constructions. For a lasting benefit from these works, it will be desirable to attend to the marginal bunds along the flanks of the newly constructed weirs. Unless the bunds are satisfactorily completed and adequate length of water channels are dug, full benefit cannot be derived from the completed works.

Before deciding upon the masonry construction of a weir, it would be desirable to study the use that the up-stream water is already being put to. Such study may bring out the advantages of combining two or more weirs at one place.

Similarly in the lay-out of the projected water distribution system, existing alignments be examined to explore the possibilities of an integrated lay-out. On Sakhri and Kumri Irrigation schemes in Bihar, this has been done for the benefit of larger area. Bihar and Bombay may have more instances where this could be profitably carried out. Other States may consider the suggestion while deciding upon the pucca construction of old weirs.

(2) *Surface water storage*

Extensive investigations are being carried out with a view to locating all feasible sites for significant storage on major and medium schemes. Possibilities of small storage should, therefore, not be many. In several situations particularly those in the hilly and undulating regions covered by the Arvalli, the Satpura, Chhota Nagpur in the Vindhya and similar tracts in Western and Eastern Ghats, it may however be desirable to have small storage in order to avoid costly construction of long water channels over rolling country. This may be of particular utility in looking after the irrigation of small patches of cultivation in such tracts. All the head water regions of the streams need, therefore, be examined for locating minor irrigation tanks. This is for the consideration of States of Bombay, Madhya Pradesh, Bihar, Andhra and Orissa.

For an economic design of the storage schemes, basic hydrological data of flood discharge, minimum flow, co-efficients of yield and run-off need be determined. Such observations may have to be initiated in the areas of the former States of Saurashtra, Madhya Pradesh and Vindhya Pradesh where observation guages on streams may have to be set up at large number of places.

For storages that are proposed in relatively drier parts of the country, the water yield from single catchment will have to be increasingly supplemented by diversion of flow from adjoining catchments. This may be examined in the State of Rajasthan and for the area of the former Kutch State.

(3) *Chain system of tank irrigation*

In States of Mysore, former Hyderabad and in Satara District of Bombay, chain system of tank irrigation has been in vogue. In a valley, series of tanks are completed, so that the surplus water from upstream tank is stored in the tank lower down. Maximum utilisation of water is thus aimed. The State of Madhya Pradesh and Orissa may examine possibilities of setting up similar chain systems of tank irrigation.

In a chain system of tank irrigation, it is important that adequate surplusing arrangements are provided particularly on the down-stream tanks so that if any tank breaches, the tanks situated lower down are saved.

(4) *Surplusing arrangement on tanks*

Every tank has to be designed for passing the flood discharge from the catchment. The flood discharge has to be carefully computed. Generally, it is determined from Dicken's formula, namely:

$$Q \qquad CM^{\frac{3}{4}}$$

Where 'Q' is the discharge in cusecs, 'M' is the sq. miles of catchment area and 'C' is the constant depending on the nature of the catchment. The value of 'C' is variable for different types of catchment and can be best determined by actual hydrological observations. If these are carefully taken and the value of 'C' accurately determined, an economic design for surplusing can be decided.

Good portions of States like Mysore, former Hyderabad and Saurashtra are frequented by strong cyclones resulting in heavy downpour either in the beginning or at the end of the monsoon period. Such cyclones require liberal provision for flood surplusing. Cyclones are, however, known to have different paths. It may be desirable to ask the Metereological Department to mark out the particular path that the cyclonic storms usually take. Ample capacity for flood surplusing need be provided on tanks that are constructed in the areas frequented by cyclones.

(5) *Evaporation losses on tanks*

On water spreads in arid regions of Rajasthan and of former Kutch, appreciable evaporation losses have been noticed. It would be desirable to decide construction of such tanks that are deep and have lower area of water spread, so that evaporation losses are minimised.

On tanks in such areas, it may be desirable to utilise the entire storage in rabi without attempting to carry over supplies to the following kharif.

(6) *Silting of tanks*

Appreciable silting of tanks is reported in States of Madras, Kerala, Rajasthan and former Kutch. Tanks in Madhya Pradesh, former Vindhya Pradesh and Hyderabad do not seem to have much of silting problem. In States where appreciable silting of tanks is observed, it would be desirable to provide initially for extra storage capacity. This will, however, have to be determined from studies that should be carried out of silt deposits on the tanks.

It may be advisable to discourage cultivation in tank beds. Also take special care of the fore-shore area as necessary in order to reduce the silting of tanks.

The restoration of a silted tank will be relatively cheap if tank are raised instead of desilting the bed. Raising of banks will however submerge additional area. It could be adopted only where the damage, due to submergence, is not very appreciable.

(7) *Restoration of old tanks*

The work of restoration generally consists of:

(a) strengthening or raising the banks;
(b) improving the surplusing capacity of the tank; and
(c) occasionally desilting the bed.

It is important that proper standards are laid down for restoration of tanks with different irrigation capabilities. Such standards would be of good guidance to the skeleton staff that has so far been possible to post to this important work. The States of Madras, Andhra and Mysore have already decided the standards for a large percentage of tanks in their States. Other States of Madhya Pradesh, Orissa and former Hyderabad need urgently lay down standards for the guidance of staff engaged on this work.

(8) *Surface water lift irrigation*

Attempts at lift irrigation have not so far been found economical. Main reason is commonly the non-availability of cheap power. At quite a few places, large pumping installations have been arranged at great cost without satisfactory arrangements for conveying rather large quantities of pumped water. It would be desirable to discourage large installations and thereby avoid over-capitalisation. This should be particularly important, as construction of large channels is not popular among cultivators with small holdings. As an alternative, it would be advisable to attempt a large number of small installations. Cultivators with small holdings will possibly find these more handy, as a lengthy construction of water channels would not be required and also heavy initial outlay would not be needed. The size of each installation would be decided on the extent of the area intended for irrigation. This would again depend upon the willingness of the cultivator to complete water channels.

(9) *Kuhls in hilly areas*

A small minor irrigation arrangement has to be made for the small patches of cultivation in hilly districts of Punjab, former Pepsu, Himachal Pradesh, and Jammu & Kashmir. As most of the streams are snowfed, some water supplies are observed all the year round. Irrigation channels that are taken out by diverting the stream flow are commonly called 'kuhls'. For the benefit of small areas, only diversion need be arranged. Not many storages have been felt necessary. It is, however, important that minimum stream flow is observed, so that irrigation potentiality is accurately determined.

Usually, the water channels have to pass through porous soil. Hence, the seepage losses are appreciable. Lining of channels may have consequently to be done at good many places. The relative economics of a lined channel has to be compared with that of an unlined channel, on which frequent vertical falls may have to be provided. Each case can be decided on its merits, but it is important that this relative analysis is done in all cases before the construction of channel is undertaken. Of course, the low maintenance cost of a lined channel should also be taken into account.

For uninterrupted running of kuhls, it is important to protect it from land-slides. Unless this is done, kuhls will quite frequently get chocked and inundated. It is, therefore, advisable to take care of the flow from all intervening drainages by providing suitable covers on the kuhls at such points.

(10) *Ground water utilisation*

Use of ground water has an important contribution towards irrigation development in the country. Nearly 30 per cent. of the total irrigation in the country is from ground water. Among the minor irrigation schemes, ground water utilisation is responsible for over 50 per cent. of the total irrigation. In the First Plan, construction of wells, tubewells and installation of water lifting appliances was encouraged. Search for new areas of ground water potentiality has been undertaken under the all-India Ground Water Exploration Project. This is primarily for locating tracts where State tubewell irrigation could be introduced as a State enterprise. On the completion of this Project, it is proposed to continue exploratory drilling under a Second Ground Water Exploration Project. This project is aimed at locating areas with smaller ground water potentiality which though not sufficient for State tubewell irrigation may be considered adequate for ground water utilisation by individuals or Co-operatives. As the unexplored areas are numerous and the Ground Water Project may not be able to expeditiously cover all areas, it would be desirable for the States to organise their own exploration with whatever drilling equipment they have with them.

(11) *Construction of open masonry wells*

Construction of open wells is the most popular use of sub-surface water. Not many new areas with ground water potentiality have, however, been opened; hence there is a tendency to overdraw on proven tracts. It was observed in Rajasthan and Bombay that fragmentation of family holdings has been responsible for the construction of increasing number of wells. New wells have even interfered and in some cases depleted the water supplies on existing wells. Wells are also getting into disuse in Bombay because of little care having so far been taken to protect the sources of water replenishment. Soil erosion in the nullah beds is one of the main reasons for a large number of wells getting into disuse in Bombay. In the future construction of wells, care should therefore be taken to see that the wells are not constructed too close and special steps should be taken to stop the retrogression in the nullahs.

(12) *Choice of pumpsets*

In specifying pumpsets, certain features have to be kept in mind. The pumpset should not have a suction lift of more than 15 feet. This is important because with higher suction lift the efficiency sharply declines. In the choice of diesel engines for running pumps, the rating of the engine for continuous running should be ascertained. Normally, the specified horse power is for running the engines for a few hours. Only half of this horse power can be depended upon for continuous running. It is important that the performance of the pumpset is estimated on the derated horse power instead of the usual figure that is meant for a few hours' running.

(13) *Filter points*

In the coastal areas of Madras, Andhra and Kerala, ground water utilisation has been in vogue through the construction of filter points. These have been popular at places where the water table is not very deep and the ground water supply is plentiful, so that pumped water table is not deeper than the suction range of the pumping sets installed at ground level. Commonly, the filter point is completed by driving the filter. This is likely to compress the sands of sub-stratum and thereby reduce its water permeability. If instead of driving the filter it is installed in a borewhole, the yield of water at the filter point would be improved.

(14) *Artesian wells*

In the West Godavri District of Andhra and South Arcot District in Madras, artesian wells have been located and tapped by drilling with 4″ and 6″ pipes. Their discharges have, however, declined mainly because:

(a) unregulated tappings—to near each other, have been done with the result that the water supplies have been interfered with;

(b) the pipes have got choked: and

(c) water under pressure of the artesian aquifer has taken to easy flow into the top strata.

Steps need be taken both by Madras and Andhra States to regulate the construction of artesian wells. Improved design would avoid (c) stated above.

(15) *Tubewells*

In tracts where gravity flow irrigation is not possible, it is advisable to take recourse to tubewells if the tract is ground water worthy. For successful running of tubewells, however, an assured source of power must be arranged. In addition, steps for introducing a pattern for intensive cultivation need be taken, so that the tubewells are kept running all-the-year-round.

Paddy cultivation in tubewell command is not very congenial to successful tubewell running. It concentrates the water requirement to a short period with the result that the tubewell command has to be curtailed to a smaller area. This does not offer a varied use for the tubewell water.

(16) *Improvement of water supplies in wells*

Cheapest manner of arranging new irrigation could be to tackle the existing wells for improved water supplies. Boring could be done in wells situated in alluvial tracts. Where the wells are resting on rocky tracts, their deepening by blasting the rock may increase the storage capacity and in addition tap new fissures for larger water supply. Several States have attempted this work but good progress has only been possible where sufficient work has been organised on sufficient number of wells in a compact block. Handling of scattered wells is very expensive and time consuming. States of Madhya Pradesh, Bombay and Rajasthan need organise these operations for improved turn-out.

(16A) *Recharge of ground water*

Improvements in ground water recharge can be effected by the construction of percolation tanks and weirs. So far, these have not been encouraged because they are incapable of bringing about direct irrigation benefit. Thier importance has, however, been recognised in a small way by the construction of Rapats in Ajmer. Importance of works that can suitably recharge the ground water should be of foremost concern to dry areas of Bombay including portions of Kutch and Saurashtra. It is suggested that observations may be carried out for assessing the area of ground water replenishment that water conservation measures, like the construction of percolation tanks and weirs, can actually bring about.

(17) *Power for water lifting*

The ground water use is likely to get more in vogue if adequate arrangements are made for water lifting. Electric power should be increasingly available with the completion of multi-purpose projects and rural electrification schemes. In the interest of lift irrigation, it would however be desirable that a definite allocation is made on all power schemes for use on agricultural pumping. All States need be asked for the steps they take in getting positive allocation of power at reasonable rates for agricultural pumping. In the past, States like Bihar, Hyderabad and Saurashtra did not have sufficient power to encourage agricultural pumping. Their rates were also high.

While availability of power is thus arranged, steps need also be taken to avoid wasteful installations, so that electrical generation arrangement is put to maximum work. In Mysore and Madhya Pradesh, several pumping installations have a higher horse power than necessary. At present, these pumping sets are running for fewer hours. With a lower horse power meter, the same irrigation benefit can be brought about by running the sets for longer hours. The owners prefer a higher horse power that need only run for fewer hours possibly because of labour difficulty. This is uneconomical for the electrical supply, as the non-agricultural consumers can make a fuller and more continuous use of electricity. For a more assured use of electric supply, the initial scrutiny of proposals need include consultations with the Agricultural and Electrical Experts in the State before sanctioning finances for pumping set installations.

(18) *Water distribution channels*

While irrigation works were quickly completed for tapping available surface water, not all the desired attention has been paid to adequate conveyance of harnessed water supply. No irrigation benefit can accrue unless the harnessed water is distributed systematically to the fields. The water distribution system, therefore, deserves as much attention as the main work. Some of the States like old Hyderabad and even Bombay have entrusted the construction of water channels upto three cusecs carrying capacity, *i.e.,* for as big areas as 200 acres, to local people. Because of lack of co-operation and non-availability of vacant land etc. channels have not been completed with the result that water is not reaching to all portions of the command that was originally projected. It would be desirable to leave the construction of only such small length of channels to the beneficiaries as would be required for say 25 acres of irrigation. This practice has been successful in the States of Mysore and Madras, and is recommended for other States as well. It may be a good scheme to have the water courses constructed by the beneficiaries in advance of the actual execution of the works.

(19) *Spray irrigation*

Because of initial heavy outlay on equipment and recurring cost of pumping, spray irrigation may not be economically feasible for general use. It may, however, be economical to operate it in hilly parts at places where the hydrostatic head may even do away with pumping. Spray irrigation has its advantages when the water available is in limited quantity

(20) *Bund construction*

In areas that have heavier texture of soil and where repeated application of irrigation water is likely to require special drainage arrangements it may be advisable to examine the extent to which construction of bunds could encourage cultivation. Bund construction may be popular if, in addition to heavier soil texture, the area is frequented by more rains during the later part of the monsoon. The construction of bunds would encourage conservation of moisture due to late rainfall in the heavier texture of the soil and thereby create favourable conditions for satisfactory growing of winter crop. Bund construction is not likely to be successful in tracts where the soil is light and the rainfall is heavy in the early part of the monsoon. Experiments are being conducted at Bellary in Andhra Pradesh for evolving satisfactory designs that could be adopted in the section of the bunds that are made with the heavy type of earth. Large-scale construction by the local cultivators could be organised on the lines done in Sholapur and Poona Districts of Bombay.

(21) *Steps for accelerated construction*

Minor irrigation constructions aim at maximum utilisation of local resources and talent. As most of the constructions are planned in cultivated areas, the local labour and resource can be best available for the construction of minor irrigation schemes only during slack periods of agricultural activity. In certain parts of Rajasthan and North Bombay, construction works can perhaps be in full swing only after the first rain shower. Any construction that does not take full advantage of this slack period in agricultural activity will have to necessarily wait for the next season. It is for this reason that progress on minor irrigation works has been protracted for more than a year even though they are capable of being finished within a few months of concerted activity. In order that maximum use is made of the availability of labour in this period, it is very important that sanction for the construction and funds for payment reach the field officers well in advance of this slack season.

Some cases of protracted construction were noticed in Orissa and Hyderabad. Other States may have similar experience. There appears good scope for all States looking into and organising such procedure that would convey the sanction of works and funds to the field officers well in time for maximum construction progress during the slack period of agricultural activity.

In addition to improving the procedure for sanction of works and funds, it would also be advisable to take an account of the labour availability in the area. In fact, a prior census of labour would be extremely helpful in organising works. Labour does not find it convenient to leave their villages for construction works that are beyond five miles radius. It would, therefore, be desirable to sanction works in any area after taking account of the available labour strength and their maximum turn-out during the months of slack agricultural activity.

(22) *Popular contribution*

The most outstanding use of local resource and talent is evident on the commendable progress made in the construction of individually owned works like wells, installation of pumping appliances, etc. On group works, the contribution has been significant only in dry areas where usefulness of irrigation is firmly established. Contribution in cash has been more popular than the offer of labour. This is generally true on works that are taken up in tracts that are already developed. In backward areas, people are too poor to pay in cash at the start of the work. On the construction of contour bunds in Sholapur and Poona Districts of Bombay, local labour has worked on payment of lower wages. Popular contribution has been relatively more for the construction of new works that are undertaken consequent to the initial suggestion of the local people. On restoration works, the popular contribution is generally feeble, as the people either expected the old landlords or the Government to restore the existing works. In Bombay, the State has been consistently insisting on a prior popular contribution before the Government part of the finances could be made available for starting the contructions. This has not been very popular and has frequently resulted in very poor progress of minor irrigation constructions. In the case of backward areas, it can be explained by the inability of the cultivators to muster up the necessary funds. It should, therefore, be desirable for the Government to initially make available the entire required outlay and recover the local people's contribution in instalments that would offer the beneficiaries a chance to improve their irrigated agriculture.

(23) *Sanction of subsidy.*

On individual works like wells, pumping sets, filter points, the GMF Rules permit subsidy being offered to the extent of 25 per cent which, in the case of backward areas, is permitted even upto 50 per cent. The total subsidy is equally shared between the State and the Centre. Balance amount required for completing the works is being offered as loan. The State of Bihar, however, does not ask finances for the loan part and has been merely offering payments of the subsidy portion either in one lot on the completion of the work or in phased payments on partial completion. In this manner, it has been possible in Bihar to encourage the construction of a large number of works with the limited finances made available to the State. Other States may examine the possibilities of adopting similar practice as is prevalent in Bihar.

(24) *Record of completed works.*

All completed works should be brought on record, so that their behaviour is regularly watched.

Estimates of works should be closed on completion, and further repairs should not be a charge on the initial finances.

Initial outlay on all individual works should be recorded, so that any later requirement of funds for repairs could be judged on the merits of earlier expenditure.

(25) *Legislative enactments.*

Legislative enactments are necessary for authority to (a) enforce certain standards of maintenance and in case of lapses to take over the work and recover the expenditure incurred in its restoration; (b) provide penalties being imposed on those who interfere in systematic utilisation of water resources, and (c) declare a commanded area under irrigation work as compulsorily assessed and thereby making irrigation obligatory.

The States of Madhya Pradesh, Madras, Andhra, Mysore, Kerala and Bombay have already passed Acts which provide for the above three clauses. Remaining States had better consider legislation on these lines. Clause (c) is worth serious consideration of States like Bihar, West Bengal and Orissa which have a higher annual rainfall. Because of high order of rainfall, water supplies on even minor irrigation schemes can be depended upon. It should, therefore, be possible to demarcate the irrigable area. Compulsory assessment on the other hand would stimulate irrigation and ensure satisfactory maintenace.

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Having passed the Acts, all States do not seem to have enforced the provisions of clause (a) for ensuring adequate maintenance by the beneficiaries.

Care should, however, be taken to avoid what has happened in the case of a large number of breached tanks in Hyderabad. Irrigable area on all tanks was assessed at a uniform rate, but the beneficiaries were permitted a remission in their dues in case the water supplies from the tanks become uncertain. The beneficiaries have, in quite a large number of cases, taken advantage of this provision and have got the water supply from these tanks declared as "uncertain" even though it was within their capability to restore the breaches by doing some earthwork.

(26) *Finances for maintenance.*

Individually owned works like those of wells, pumping sets, etc. will be looked after by the owners. Similarly, works that are constructed and maintained by a small group of cultivators would not require much finances for maintenance. This is particularly true of dry areas where the use of irrigation is fully recognised by the cultivators. There are, however, large number of works which have been restored by Government and whose maintenance thereafter has been entrusted to the beneficiaries. In order to encourage their maintenance, a levy on entire irrigable area is imposed. This practice is in vogue in the States of Mysore, Madhya Pradesh, Madras. The remaining States need impose similar levy.

Under a third category of works are those that have been restored by Government and are being maintained by them. Here again, the entire irrigable area should have a regular charge to defray the annual maintenance expenditure and for special repairs. Madras, Andhra, Mysore, Hyderabad, and Bombay have arranged maintenance through Governmental agency on works that have sizable irrigation capability varying from 200 acres in Madras and Andhra to 100 acres in Bombay.

(27) *Organisation for maintenance.*

Minor irrigation works costing upto Rs. 10 lakhs are of different sizes. Starting from individual works like wells, pumping sets and filter points, there are small irrigation works of significant size. Some of the works are capable of looking after even 10,000 acres of irrigation. These require proper technical supervision in their maintenance. Such works are invariably in the charge of Engineering Department in the State. While Madras and Andhra include in this category works that irrigate upto 200 acres, Bombay has kept it at 100 acres. For even smaller works in Mysore, the State P.W.D. is responsible, though Madras, Andhra and Bombay entrust their Revenue or Community Development Department the responsibility for maintenance of such small works. These Departments are not, in all States, staffed with technical hands. It is desirable that these States recruit technical men with previous experience for looking after the normal repairs. For special repairs, the Public Works Department in the State need be consulted. It was also observed that special repairs have been felt necessary once in five years.

The maintenance responsibility of tanks with irrigation capability lower than 50 acres could be entrusted to local organisations like Panchayats, Gaon Sabhas etc. In States like Bihar, Bengal and Orissa where the irrigation works are only for supplemental use, the local people may not initially be alive to this responsibility. Consequently, Governmental set up will have to be more watchful till the irrigation benefits are finally established and grow into a recurring use.

(28) *Shortage of technical personnel.*

Shortage of junior staff has been felt invariably by all the States. States like Himachal Pradesh, Tripura and Manipur which are isolated and have got difficult terrain have not been able to attract qualified hands from outside. Even those who join, very soon leave the assignment with the result that important levelling for initial survey and estimating has been sadly neglected. Work of levelling forms a major portion of the duties expected of subordinates. This shortage could perhaps partially be met with by recruitment of Surveyors who are well up in levelling even though they have not got all the qualifications that make up an Overseer. The States may start training classes for a short-term course of, say, six months which would primarily be for training the hands in the work of levelling. Local people familiar with the area and with aptitude for cross-country work could be trained and thereafter employed as Surveyors. This may relieve the shortage of technical subordinates specially in the States like Himachal Pradesh, Manipur and Tripura.

(29) *Assessment of irrigation benefit.*

Irrigation benefit on most of the schemes is at present being reported on the basis of the initial forecast. Actual figures of irrigation have so far being collected only for works that the Irrigation or Public Works Department in the State have under their control. On other works (particularly in States like Orissa, West Bengal and Bihar) no systematic measurement of benefit has been undertaken. In U.P., Bombay, Madras and Andhra, the irrigation benefit comes under review in the normal routine of the Revenue staff during their assessment of agricultural cropping. While Orissa, West Bengal and Bihar need organise regular measurement of irrigation benefit in addition, it appears desirable for all States to arrange for random survey through an independent organisation like the Statistical Section of Bombay, Madras and Andhra.

In Madras and Andhra, the entire irrigable area is subject to a wet assessment. This is a good incentive for beneficiaries to take full advantage of the irrigation water. It is suggested that other States particularly Orissa, West Bengal and Bihar may also examine the possibility of adopting this method.

APPENDIX I

(To be published in Part I Section I of Gazette of India)

No. F. 9-5/55-IRN.

GOVERNMENT OF INDIA

MINISTRY OF FOOD & AGRICULTURE

New Delhi, the 12th July, 1955.

RESOLUTION

The Second Five Year Plan envisages further extension of minor irrigation facilities in the various States. For proper planning of the various irrigation schemes, it is necessary to assess the work already done in this field and to determine the overall scope for further expansion. The Government of India have consequently decided to set up a Committee to (a) collect available data with regard to minor irrigation works, (b) examine the difficulties experienced by the States and the scope for further expansion and (c) render all possible assistance and guidance and to make suitable recommendations to enable the States to launch their schemes on a more sound footing.

2. The composition of the Committee shall be as under:—

(i) Irrigation Adviser to the Government of India, Ministry of Food and Agriculture—Convener.

(ii) Director (W.I.N.), Central Water and Power Commission, Ministry of Irrigation and Power—Member.

(iii) A representative (preferably Chief Engineer) of the State concerned—Member.

3. The Committee will have power to co-opt any other Member.

Ordered that the Resolution be published in the Gazette of India for general information.

(Sd.) M. LAL, Joint Secy.

Ordered also that a copy of the Resolution be communicated to all the State Governments with the request that they should intimate the name of their representative on the proposed Committee.

Ordered also that a copy be forwarded to the Convener, Members of the Committee, all Ministries of the Government of India, Central Water and Power Commission, E. and S. Directorate, Planning Commission and

Community Projects Administration. A representative of the Directorate of E. and S. shall assist the Committee in collecting the necessary data. He will not, however, be required to tour with the Committee.

Copy to all Sections concerned.

By order,

(Sd.)

Officer on Special Duty.

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APPENDIX II

NAMES OF STATE REPRESENTATIVES ON THE MINOR IRRIGATION COMMITTEE

1. Shri B. P. Saxena, ISE, Chief Engineer, Irrigation Deptt., U.P.
2. Shri H. K. Nivas, ISE, Chief Engineer, Irrigation Deptt., Bihar.
3. Shri B. N. Banerji, Jt. Director of Agri. (Engg.), West Bengal.
4. Shri U. S. Mahida, ISE, Chief Engineer, Irrigation, Bombay.
5. Shri H. Anantachar, Chief Engineer, Mysore.
6. Shri J. C. Hardikar, Chief Engineer, Hyderabad-Dn.
7. Shri P. S. Rajagopalan, Senior Executive Engineer, Panchayat Department, Travancore-Cochin.
8. Shri P. V. Divatia, Chief Engineer, Irrigation, Madhya Bharat.
9. Shri C. M. Bennet, Chief Engineer, P.W.D., Orissa.
10. Shri Moti Ram, Chief Engineer, Irrigation, Rajasthan.
11. Shri H. M. Antani, Principal Engineering Officer, P.W.D., Kutch.
12. Shri G. R. Nangea, Chief Engineer, Himachal Pradesh.
13. Shri J. N. Mitra, Principal Engineering Officer, Vindhya Pradesh.
14. Dr. J. C. Ramchandani, Development Commissioner, Delhi.
15. Shri S. D. Kalra, Deputy Secretary, Govt. of Pepsu.
16. Shri U. Ananda Rao, Chief Engineer, Irrigation, Madras.
17. Shri Narasimha Rao, Addl. Chief Engineer, Andhra.
18. Shri Fahim Beg, Chief Engineer, Bhopal.
19. Shri F. P. Bulakani, Executive Engineer, C.P.W.D., Ajmer.

APPENDIX III

MINISTRY OF FOOD & AGRICULTURE (AGRICULTURE)

QUESTIONNAIRE TO STATES REGARDING MINOR IRRIGATION WORKS

A. GENERAL

(1) What is the total expenditure incurred so far on different minor irrigation schemes in the State? Separate figures of expenditure during 1951-52 and onwards may be quoted for schemes that are classified as public works as distinct from those that are treated as private works. Among private works may be included such schemes that were partly or wholly financed by the State but were either constructed or are being maintained by individuals or by a group of individuals.

(2) Total number of different types of schemes, both public and private, completed may be quoted year-wise. As against this number, please state the number of schemes that are registered on Governmental records. Steps taken for the checking of balance number of schemes may be stated.

(3) How many of these schemes have brought about permanent or temporary benefit? Maximum area irrigated and recorded may please be stated for each type of scheme.

(4) In case special surveys have been carried out on the unrecorded schemes, findings of such survey may be supplied particularly regarding the works that may have gone into disuse.

(5) What is the achievement so far and what are the prospects for reaching the target of minor irrigation works laid down in the First Five Year Plan?

(6) Among future minor irrigation schemes, what percentage of proposals would be for carrying out improvements to existing works?

(7) What are the possibilities of increasing irrigation benefits on the existing schemes by improving the water conveyance through lining of channels and by adopting better arrangements for efficient water distribution?

B. SURVEY ARRANGEMENTS

(1) Has the State got separate survey staff for investigating minor irrigation possibilities or, in the alternative, are such surveys entrusted to the maintenance or construction staff posted to different areas in the State? In either case, what has been the number of minor irrigation schemes that the present staff has been able to prepare? In case separate survey staff has not previously been appointed what are the prospects of setting up a separate survey staff? What time would this staff take to completely investigate all possible minor irrigation schemes in the States.

(2) What difficulties, if any, have been experienced in the recruitment of staff—subordinates and officers? Has the State taken special steps to accelerate the training of Engineers, Overseers and Mechanics? If so, to what extent this would meet the requirement of additional personnel for the survey and implementation of minor irrigation schemes that the State has in view?

C. WELLS

(1) Please indicate the tract where the water availability on open dug wells is more than what is at present utilised.

(2) In what manner can the water supply on existing wells be improved? Which will be more popular: deepening the well by boring or by blasting the bottom of the well?

(3) Which is the most popular appliance in different areas of the State used for water lifting on (a) wells and (b) streams?

(4) What are the prospects for working pumpsets in cases where they are not already installed?

What are the possible reasons for such wells not being powered so far? Is it because the individual owners of the well have small holdings or they lack necessary finance?

(5) What would be the popular choice between the alternatives of installation of a large number of small pumping sets as compared to setting up of a fewer number with bigger capacities on streams and running them either by the State or by Cooperative Societies? Has any water lifting been previously worked through Cooperative Societies and, if so with what results?

D. TUBEWELLS

(1) Have any tubewells been previously constructed either by Government or by private parties in areas with no possibility of flow irrigation? If so, what area has normally been irrigated from such tubewells?

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(2) Has there been any marked difference in the behaviour of tubewells particularly in respect of their discharge and depression?

(3) What has been the effect on water table depth consequent to tubewells pumping?

(4) If large scale extraction of underground water through tubewells has resulted in the lowering of the water table, whether the State Government have taken any steps or propose to take any steps to ensure sustained groundwater availability by regulating its extraction by means of legislation or by any other means?

(5) What steps are being taken for the development of agriculture in State tubewell irrigated areas for fuller utilization of tubewell water?

(6) Are the prevailing tubewell irrigation rates popular? How does the average rate on tubewell supplies compare with other irrigation rates in the State?

(7) Unirrigated areas may be indicated where groundwater is not deeper than 30 ft. and the surface water in the streams is not below 40 ft. In hilly tracts, even areas with stream water at 60 feet deep may be included.

(8) What are the prospects of hydro-electric or steam generated electricity being available in such areas? Has any diesel operated water lifting appliance been attempted before; if so, with what results and what have been the difficulties?

E. STORAGE

(1) How have the previously constructed storage tanks behaved? Has there been any decline in the irrigation area on these tanks; if so, please give reasons?

(2) What are the prospects of augmenting water supply from neighbouring catchments of the existing tanks?

(3) Has desilting been tried on tanks whose capacity has been sharply reduced because of non-clearance? If so, what would be the popular choice between desilting of tanks and raising of the banks for increased storage?

(4) What attempts have been made for evolving an economic design for surplusing an occasional flood water in the small catchments of minor irrigation tanks?

F. BUNDS

(1) What are the prospects of intensive constructions of contour bunds for conserving both water and soil in the area?

(2) Have such bunds been previously constructed; if so, what has been the average cost per acre and how was the earthwork carried out by men or by machines?

(3) What is the arrangement for maintenance of contour bunds? How much of additional agricultural cultivated area can be contour bunded? What are the merits of bunding as compared to construction of tanks for storage of water?

G. DIVERSION WORKS

(1) What is the ratio of permanent and temporary works constructed across streams and nallas for diverting irrigation water supplies? In case of permanent constructions, how have the streams behaved consequent to the completion of work?

(2) On diversion work completed in hilly areas, has there been any defection in the quantity of irrigation water on account of excessive silt charge?

(3) How does the actual irrigation figure compare with the forecast irrigation capabilities of such diversion works?

H. CROPPING PATTERN

(1) To what extent have minor irrigation schemes contributed to stepping up the production of cereals?

(2) What percentage of the irrigated area on minor irrigation schemes is under each crops like sugar-cane, cotton, etc.? What are the prospects of increasing such areas particularly on lift irrigation arrangements for making them self-financing?

(3) What are the yardsticks utilised in calculating additional production for each category of minor irrigation schemes?

(4) What are the basis and assumptions on which these yardsticks have been framed?

APPENDIX IV

LIST OF OFFICERS OF THE STATE GOVERNMENTS WITH WHOM DISCUSSIONS TOOK PLACE

1. Shri A. C. Mitra, ISE, Chief Engineer, Irrigation, U.P.
2. Shri K. A. P. Stevenson, IAS, Secretary, Agriculture Deptt., U.P.
3. Shri B. P. Saxena, ISE, Chief Engineer, Irrigation, U.P.
4. Shri H. K. Nivas, ISE, Chief Engineer, Irrigation, Bihar.
5. Shri H. N. Thakur, IAS, Jt. Secy., Agriculture Deptt., Bihar.
6. Shri R. Prasad, IAS, Secretary, Agriculture and Planning Deptt.
7. Shri B. N. Banerji, Jt. Director of Agri. (Engg.), West Bengal.
8. Shri G. Banerjee, ICS, Development Commissioner, West Bengal.
9. Shri C. K. Ray, IAS, Secy., Agri. Deptt., West Bengal.
10. Shri I. B. De, ISE, Chief Engineer, Irrigation. West Bengal.
11. Dr. H. K. Nandi, Director of Agri., West Bengal.
12. Shri S. P. Mohite, IAS, Addl. Development Commissioner, Bombay.
13. Shri J. P. Naigamvala, Dy. Secy., P.W.D., Bombay Govt.
14. Shri S. G. Valavalkar, Under Secy., Agri. and Food Deptt.
15. Shri M. D. Wadia, Dy. Director, Cooperative Farming, Bombay Govt.
16. Shri H. Anantachar, Chief Engineer, Mysore.
17. Shri J. C. Hardiker, Chief Engineer, PWD, Hyderabad.
18. Shri P. S. Rajagopalan, Senior Exec. Engr., Panchayat Deptt., Trivandrum.
19. Shri P. V. Divatia, Chief Engr., Irrigation, Madhya Bharat.
20. Shri C. M. Bennet, Chief Engineer, PWD, Orissa.
21. Shri M. Ramakrishnaiya, IAS, Secy., Agri. Deptt., Orissa.
22. Shri S. Parkash, Director, Community Projects, Orissa.
23. Shri B. S. Mehta, Addl. Chief Secy., Rajasthan.

24. Shri Kesri Singh, Secy., Board of Revenue, Rajasthan.
25. Shri Samrath Raj, Director of Agriculture, Rajasthan.
26. Shri M. L. Sud, ISE, Chief Engr., Irrigation, Madhya Pradesh.
27. Shri H. M. Antani, Principal Engg. Officer, P.W.D., Kutch.
28. Shri G. R. Nangea, Chief Engineer, Himachal Pradesh.
29. Dr. J. C. Ramchandani, Devl. Commissioner, Delhi.
30. Shri J. N. Mitra, Principal Engg. Officer, Vindhya Pradesh.
31. Shri S. D. Kalra, Deputy Secy., Pepsu Govt.
32. Shri U. Ananda Rao, Chief Engr., Irrigation, Madras.
33. Shri P. Sivasankaran Pillai, Dy. Secy., Agri., Food and Prod. Deptt., Madras.
34. Shri Narasimha Rao, Addl. Chief Engr., Irrigation, Andhra.
35. Shri Fahim Beg, Chief Engineer, Bhopal.
36. Shri Dikshit, Development Commissioner, Bhopal.
37. Shri P. S. Lamba, Director of Agriculture, Bhopal.
38. Shri F. P. Bulakani, Exec. Engr., C.P.W.D., Ajmer.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON HYDERABAD

(1) OUTSTANDING FEATURES

The State of Hyderabad is on an elevated plateau of average height of 1200 feet above mean sea level. Occasional hills rise even as high as 3500 feet. On the west, the State is flanked by the Western Ghats. There is a general slope in the ground surface from north-west to south-east. Two prominent rivers of Godavari and Krishna along with their several tributaries spread their benefits more or less uniformly throughout the State. Water is, however, not available all the year round. The State gets rainfall from both the south-west and the north-east monsoons) The western portion has the south-west monsoon from June to September. In the eastern half, three-fourth of the rainfall is from south-west monsoon and the rest from north-east during October and November. (The annual precipitation ranges from 18″ in the south-west to around 40″ in the north-east. Situated on the leeward side of the Ghats, the western portion of the State has relatively small rainfall.) Cyclonic storms have frequently been responsible for several cloud bursts. [Strong wind velocities and relatively high temperatures have generally brought about appreciable water evaporation loss at storage tanks. At places, as much as 6 feet of water loss has been reported in a year; maximum figures being in the period between May and September particularly in the western part of the State. Soil varies from area to area, but black soils prevail in the major western part of the State; the east is overlaid with sandy loam. The deep and medium black soils have a tight texture with rather slack drainage capability. The sub-strata is either Deccan trap or granitic. All these geological formations are incapable of yielding abundant or prolific groundwater supplies.

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(Administratively, the State is divided into two parts; the portion lying to the east of north-south line along the 77°-40′ longitude is called Telengana, while the werstern portion is named Marathwada and also includes the Karnatak Districts of Raichur, Galburga and Bidar. These portions are inhabited by the Telgu speaking, the Marathi speaking and the Kannada speaking people respectively.

(2) IRRIGATION PERFORMANCE

(i) *Old works.*—The importance of conservation, control and utilisation of waters flowing down the many rivers and streams for irrigation purposes seems to have been realised many a century back with the result that the whole of Telengana is studded with thousands of surface tanks.

and artificial lakes, constructed by the ancients, which help the cultivation of rice, the staple food of the people. There are no less than about 35,000 surface tanks, big and small, and notable among the big artificial lakes are Pakhal, Ramappa, Laknawaram, Shanigaram and Ghanpur tanks said to have been constructed by the Kakatiya Rulers in the 13th Century A.D.

The ancients of the Karnatak area also seem to have been alive to the benefits from the utilisation of rivers and streams for irrigation purposes. The eight famous anicut systems of Tungabhadra River in Raichur District which date back to the days of Vijayanagara Kings are the standing proof of their irrigation endeavour.

The cultivators of Marathwada, though averse to intensive wet cultivation, were all the same forced by the capricious nature of rainfall in the tract to resort to artificial irrigation especially for garden crops. Their chief source of irrigation was wells, but in some places infiltration galleries with collecting wells and distribution channels were also constructed, examples of which still exist in Bhir and Aurangabad Districts.]

(ii) *Irrigation area.*—While old works were mainly small in size, the ancients had stored water even in big lakes of Laknawaram, Pakhal, Ramappa etc. Recently, major works of Nizam Sagar and Tungabhadra have been completed. The total irrigation in the State has, however, not exceeded 7% of the cultivated area. The crops needing most of the irrigation water are paddy and sugarcane in Telengana; and Rabi, Kharif Cotton in Marathwada. Maximum irrigation benefit has been afforded by the surface water storages and its allied canals. As such as 65% of the total irrigation is from the tanks and canals; the balance has mainly matured with use of groundwater on wells. Quite recently, attempts have been made for constructing field embankments and contour bunds with a view to conserving both soil and water. Dry farming methods have been tried with some measure of success in the Districts of Adilabad in Telengana, Aurangabad, Bhir and Osmanabad in Marathwada and Raichur, Gulburga and Bidar of Karnatak. Total area thus served would aggregate to 31,703 acres (15,292 acres in 1954-55 and 16,413 acres in 1955-56). Simultaneously, thousands of surface tanks have been repaired and restored to proper standards. Out of the total 35,000 tanks, about 13,000 have an area of less than 10 acres; 14,000 tanks between 10 and 50 acres and the rest above 50 acres. The smaller tanks having less than 10 acres area are looked after by the cultivators themselves under the guidance of the Revenue Department. The Irrigation Department attends to repairs and restoration of all the tanks irrigating more than 10 acres area but regularly maintains only those restored tanks which have more than 50 acres area. Breaches on these tanks and their repairs are almost regular features particularly in areas subject to extraordinary heavy floods due to cyclonic storms. Such heavy downpour invariablv affects the smaller tanks.

(iii) *Jagir tanks.*—Quite a large number of tanks have been taken over from the old estates consequent to their abolition. Repairs to these tanks had not been attended to by the landlords for several years. Their condition consequently deserves immediate attention. A large number of these tanks are situated in the Telengana area of the State.

(iv) *Recent Minor Irrigation works.*—Tanks were not popular in the other two regions of Marathawada and Karnataka though recently quite a few tanks have been completed in these two areas also. Relatively wells' construction was more popular in Marathawada and Karnataka regions. Water lifting has been generally by leather buckets of Motes. Diesel driven pumpsets have gradually been introduced. In no area, steam or hydro generated electricity is available for lift irrigation.

Minor irrigation schemes are not expected to include such schemes that cost rupees ten lakhs or more. The irrigation area benefited from all the minor irrigation schemes during the last five years is given below. It would appear that the peak performance is in 1954-55. Progress is reported to be maintained in later years.

Sl. No.	Source of irrigation	Irrigated area in Hyderabad State				
		1950-51	1951-52	1952-53	1953-54	1954-55
No.				(In acres)		
1.	Govt. Canals	2,06,930	2,37,262	2,14,492	2,28,198	2,54,194
2.	Private Canals	15,023	11,984	5,402	11,218	7,411
3.	Tanks	6,81,260	8,95,052	5,98,588	11,27,238	10,68,086
4.	Wells	5,44,794	5,70,561	5,92,753	5,33,975	6,38,179
5.	Other sources	52,974	65,521	26,431	49,424	58,739
		15,00,981	17,80,380	14,37,666	19,50,053	20,26,609

Cost of each of the above schemes varies from place to place, but the average figure for each type of scheme would be around Rs. 150 per acre on tanks; Rs. 500 per acre of well irrigation and Rs. 150 on account of installation of lifting appliance.

Time for completing different types of schemes has also been varying on account of a large number of factors. Generally speaking, a tank construction takes a year; a well completion six months and the installation of water lifting appliances three months.

Irrigation on all the minor schemes matures almost immediately because land is generally developed and water requirement more or less established. On sizeable tanks of over 100 acres irrigation capability, the full irrigation area may, however, not materialise in full earlier than a year. The schemes of well construction or installation of lifting appliances have been generally through individual efforts. No large-size water lifting from streams has so far been attempted by a cooperative organisation.

Collective effort has, invariably been sought in the construction of the tanks. Initial suggestion has so often been brought out by the people themselves who came up with either a grievance in regard to the repair to an existing tank or with a suggestion for the possiblities of a new tank construction. While the people provided the starting point for investigations, not much collective effort was evidenced in the construction of such proposals that were finally approved for implementation.

In the construction of all tanks, need for technical assistance has been felt at different stages of survey, design, supervision of the skilled part of the construction and finally in the measurement of work before it can be paid off. Such technical assistance in the case of Hyderabad has to be provided exclusively by the PWD. Wherever the tanks were in the charge of the Revenue Department, the PWD had to be called for technical advice, as the Revenue Department did not have any technical talent. On the schemes that were taken up by the individuals, the State had only to arrange for the procurement of certain construction materials like steel, cement and pumping equipment.

In regard to the assessment of irrigation benefits, the State has been very particular in applying a higher rate of land revenue for all fields that are provided with irrigation facilities. Thus it was frequently noticed that all the area in the command of a work recently completed was subjected to irrigation assessment. In good many cases, this affords an incentive for the cultivators to quickly complete the water distribution channels, so that they are able to utilise the irrigation water, for which assessment had already been levied. For the construction of water channels, the general policy in the State has been to construct channels bigger than 3 cusecs and expect the beneficiaries to construct the smaller size channels required for reaching water to their fields. Increased land revenue assessment is made even on works completed by individuals though a reduced rate is permitted on irrigation by lifting. This procedure assures the revenue return to the State and should indirectly sustain the benefit once it is arranged satisfactorily. The individually owned schemes are looked after by the owner and kept in proper condition, so that all the area subject to a higher land revenue derives maximum benefit. On the other works where the maintenance rests with Government, both the Revenue and the PWD authorities periodically check record of benefit on each work. The PWD insists on a 10 yearly return from the Revenue Department and takes care to arrange repairs to such works where the benefited area has sharply declined. In actual practice the PWD is not able to tackle works where the repairs are estimated to cost less than Rs. 500. Thus no normal repairs are done by the PWD to tanks that have irrigation capability below 50 acres. In such cases, only special repairs are done by the PWD and in actual experience, such special repairs are generally after 3 years. Sometimes, more frequent repairs have to be undertaken because the beneficiaries neglect their responsibilities on a breached tank. The increased wet assessment is relaxed on the ground of defective water service though most of the breaches can be set right by the beneficiaries themselves.

The PWD staff posted for maintenance of tanks in the Telengana area comprises of one Supervisor and an Overseer in each taluqa. With this staff, the PWD has been able to lay down standards for proper maintenance on only 6,500 out of 21,400 tanks (of 10 acres and above) in the State. Absence of standards is a handicap to satisfactory irrigation on tanks in the State. Neighbouring States of Mysore, Madras and Andhra have completed standards for almost all the tanks in the State. Staff will have to be strengthened till standards are finalised for all tanks.

(3) PROSPECTS

Irrigation storage.—Total surface water run-off anticipated from the geographical area of 52 million acres will be of the order of 31 million acre feet. Reckoning on an irrigation water depth requirement of 3½ feet, the maximum extent of land that can be irrigrated from surface water would be around 9 million acres. So far 1.33 million acres only are irrigated from tanks. Accelerated utilisation of the surface water resources can be made on three types of schemes, *viz.* major, medium and minor. The relative cost of these works would be around Rs. 500, Rs. 350 and Rs. 250 per acre respectively. Time for completing these three types of works is usually 5, 3 and 2 years respectively. Major schemes are capable of carrying over water storage even from one year to another. The medium schemes are, however, only capable of taking over the seasonal storage. On minor schemes of significant size, it should be possible to tide over rainfall deficiencies between early and late part of the monsoon season. The irrigation development on minor schemes is almost immediate, while medium and major schemes take some years to reach the projected irrigation capability. There are general relative merits of the three types of schemes but there are certain areas where one type of scheme would be more suitable than the other because of topography. It would be desirable to encourage construction of all the three types, so that the most economical irrigation arrangement is finally completed for the special requirements of a particular area. In a concurent plan of all types of schemes, it is very necessary that overlapping of the relative benefits is avoided. With proper planning, it should be possible to coordinate these three types of utilisation on all new works that are undertaken. In the case of existing works like small tanks that fall within the command of a major scheme, it may be advisable to permit their continued maintenance specially during the early years of irrigation development.

The specific example of the command on Nizam Sagar tank was examined, and it was observed that a large number of old tanks helped in meeting the occasional irrigation demand, *e.g.* the watering required for paddy seedlings. In this particular case, the small tanks have their own independent catchment areas and their filling does not, therefore, interfere with the runoff into the major Nizam Sagar. At any time of sporadic scattered irrigation requirement, the small tanks can locally meet with the demand and thus save the necessity of long distance water conveyance in big channels. Existence of similar set of small tanks in the catchment area of a major tank was not noticed, but this may even be considered for the benefit of highland areas which would otherwise have no irrigation though they contribute to the runoff that benefits lower down.

Lift irrigation.—Besides storage of surface water, yet another utilisation is possible by adopting lift irrigation schemes on streams in which adequate water supplies flow. Such lift irrigation schemes can, however, be more economical if and when hydro-electric power or steam generated electricity is available. For the present, only diesel power can be arranged. Water lifting with diesel power may be attempted through a cooperative society of irrigators.

Irrigation with groundwater.—Though surface water utilisation has had maximum attention of the State, groundwater has not attracted equal study. Some 20 years back, systematic groundwater use was planned, but exclusively for rural water supply. It should be possible to re-set this plan for irrigation from groundwater. The only irrigation use that has been encouraged in recent years is by way of offering financial assistance for construction of wells by individual owners. Well construction has been adopted prominently in Marathwada and Karnatak areas. These areas are underlaid with Deccan trap; hence the only possibility of groundwater availability is in the horizontal layers that may come across between two lava layers. All these layers should be horizontal; hence it may be easier to determine their levels and thereby decide the availability of such water bearing layers. Thus most shallow location of these layers has generally been found out, but it is necessary to fathom the location of the next horizontal layer which may be carrying water under sub-artesian pressure. Systematic investigations need be undertaken by employing geo-physical equipment in addition to planning systematic drilling. It would also be important to regulate the existing recharge conditions to the acquifers that are responsible for the groundwater supply on the existing sources. Such places should be traceable to the innumerable streams. There has been a definite indication of bed erosion in these streams. It would be a good thing to undertake gully plugging in the important nallas, so that proper groundwater recharge is maintained to the existing wells. Further investigations should also aim at finding out the hydraulic conditions to the second water bearing layers. For these operations, use could be made of Percussion and Calyx drilling rigs that the State has got in their possession. Some attempts have been made for improving the groundwater supply in the existing sources by boring the well bottom and occasionally blasting the rocky formation for bringing into use new fissures. In the Deccan trap areas, blasting may not be successful. Among the water lifting appliance, wide-scale use is made of the mote. Persian wheels are not so popular particularly because the water table declines sharply. Pumpsets with large length of suction pipe have recently been tried and may become more popular with electricity being made available in the rural areas.

(4) RECOMMENDATIONS

(a) *Technical:*

(i) *Design Improvements.*—Future irrigation on small tanks in Hyderabad depends a good deal on the behaviour of cyclonic storms which are most harmful to such tanks. Luckily, the cyclonic storms do not frequent the entire State. It would be desirable to ask the Metereological Department to mark out the particular path that cyclonic storms usually take. Designs of all the tanks situated in this region should provide for a surplusing arrangement that would take care of the high order of flood discharges. In fact a cheap and efficient design should be evolved for adopting on all such tanks in the State.

Quite a majority of tanks in Hyderabad have no silting problem. Cultivation in the beds of tanks is prevalent. This practice had better be abandoned. The tanks are, however, generally susceptible to high order of evaporation losses. It may, therefore, be advisible to search for such sites where maximum storage on tanks can be arranged by the minimum of water-spread.

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The soils in the State are pretty varying. Much of the Telengana area has a high percentage of porus soil; rather tight texture is repeatedly observed in the Marathwada and Karnatak areas. Drainage of irrigation water that is applied on such heavy soil would require careful design and planning. Till such time a satisfactory drainage is arranged, it may be desirable to regulate the application of irrigation water to the very minimum quantity required for satisfactory cultivation. In fact, the cropping schemes in such heavy type soil areas may be restricted to those crops that do not require heavy water application.

The water depth requirement for crops, particularly paddy, in Hyderabad is higher than the depth required in Madhya Pradesh. While extra requirement of water may be justified on account of the porosity of the soil, it is very important that only the requisite water depth is permitted. Precise requirement for different types of soils and crops had better be experimented upon.

(ii) *Water channels.*—The construction of channels of 3 cusecs carrying capacity and above is at present undertaken by the P.W.D. The smaller size water channels are entrusted to the beneficiaries. This has meant entrusting to the beneficiaries the construction of water channels for as big areas as 200 acres. The beneficiaries, in spite of the levy of increased land revenue, are not everywhere prompt in completing the water channels for such large areas. It would be desirable to require the P.W.D. construct still smaller channels and finally leave the construction of such small length channels to the beneficiaries that would be required for only 25 acres irrigation. This practice has been successfully adopted in the neighbouring States of Mysore and Madras and is recommended for Hyderabad as well.

(iii) *Groundwater use.*—In scarcity districts likes those of Bhir, Osmanabad and Gulburga in Marathwada and Nalgonda in Telengana, maximum reliance can be placed on the use of groundwater. In areas of frequent rainfall deficiency, small tanks have insufficient water storage, but the groundwater is still protected from the seasonal fluctuations. It may thus be an advantage to explore the maximum extent of areas from where the groundwater can be put to use in scarcity districts.

For sustained supply of groundwater, it may be necessary in some areas to construct percolation tanks that may not be useful for appreciable surface water irrigation but would be effective in augmenting the groundwater for use in times of deficient rainfall. At present construction of such tanks is not popular, because the extent of groundwater recharge and the benefit therefrom has not been accurately determined. Observation points should be set up with a view to determining these benefits.

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Groundwater use can further be encouraged by attempting to evolve improved methods of well lining. In some areas it may be possible to introduce concrete construction for reaching deeper depths on open wells. Use of more efficient water lifting methods would also help in the increase of irrigation area on wells.

(iv) *Bunds construction.*—Construction of field embankments as also contour bunds have been started in the districts of Adilabad, Aurangabad, Bhir, Osmanabad, Raichur, Gulburga and Bidar. So far, such embankments are constructed only in medium and light soils. In areas with heavy soils and particularly where the late monsoon is more frequently observed than the early showers, there are good prospects of such embankments being beneficial to the growth of following rabi crops. Embankments built with heavy type soils alone are subject to high order of settlement and result in breaches; hence their construction requires a prior knowledge of the soil mechanics, so that earth of requisite texture is used in the construction of such embankments.

(b) ORGANISATION

(i) *Technical training.*—On all works of Minor Irrigation, technical assistance at some stage or the other has been felt necessary. Whichever Department has been administratively in charge of the work, it has expressed difficulty in the recruitment of Overseers and Supervisors. The demand for such hands has been enormous. The State has consequently taken steps for training of increasing number of Overseers and Supervisors. So far, arrangements are for turning out 280 Overseers and Supervisors per year. It may be advisable to step up this rate of training and in addition make arrangements for a short-term education and practical course in the special work of surveying and levelling. A very heavy order of requirement is anticipated for Surveyors.

(ii) *Mobility of staff.*—The present shortage of technical staff is further aggravated by the lack of adequate transport arrangements. The scanty staff is unable to cope with the scattered works because too much of their time is used up in moving to the site. It is certain that provision of jeeps would make the staff more mobile and should definitely result in a larger turnout from the existing staff.

(iii) *Funds availability.*—Present financial rules requires the closing of accounts on 31st March. Thereafter the sanction of funds takes some time with the result that most of the works cannot be taken up prior to setting in of monsoons. The months of April, May and June are generally part of the non-agricultural season when in most parts of the State there is not much agricultural activity. Agricultural labour should be available in plenty during these months. In addition, the fields have not many standing crops to hinder the expeditious construction of water channels. On account of lack of financial sanction, not much use is made of the availability of land and labour at this time of the year. Once the monsoon sets in, there cannot be much activity with the result that the construction of works gets into swing only at the commencement of the cold weather when it comes in clash with maximum agricultural activity in evidence everywhere. Local agricultural labour is not available at that time; consequently hired labour has to be imported from other areas through the agency of contractors. Maximum progress can be best anticipated in the non-agricultural season between the harvest of rabi and prior to the monsoon season. Full advantage of this season cannot be taken unless financial sanctions etc. are available in time. Suitable steps need be taken to improve the procedure that would make available funds in time for maximum activity on construction during April, May and June.

(iv) *Popular contribution.*—Minor irrigation is basically aimed at including all works that can be constructed with maximum use of local resource and talent. This has been true to a great extent on the individual efforts that have been made by the local people in constructing wells, tubewells and installation of pumping sets etc. on their own initiative. Collective effort has, however, not been in evidence on a large number of works, particularly those that are of some significant size. Cooperation in the implementation of Minor Irrigation has, however, made a start on small works where relatively fewer number of people are involved. Popular contribution can best be assured on a very small size work that can be carried out by the beneficiaries themselves in the agricultural off-season period without their having to move over long distances. This is specially true in areas that are not so very well developed. Where, however, the area is developed, the beneficiaries even insist that the local organisation of Panchayat or the Local Board should undertake such works out of the general taxes. The general set-up of Panchayat has not everywhere got a predominance of irrigation beneficiaries. At such places, while the Panchayat is able to look after the growth of relatively conveniently situated communal institutions of schools, sanitation etc., they cannot pay equal attention to irrigation works that benefit fewer members. In the interest of sustained irrigation activity, it may be worthwhile to set up some Irrigation Panchayats that can pay exclusive attention to this important aspect of agricultural production.

(v) **Rates.**—Immediately an irrigation work is completed for the benefit of a certain area, the State takes steps to assess the irrigable area at an enhanced land revenue. This applies to all types of works whether individual or otherwise. The idea of this compulsory levy is possibly to stimulate the use of the new facility to the maximum extent. Cultivators, in some areas, are known to have made special efforts at proper conveyance of the irrigation water through channels that they themselves cooperate to construct. Such places are, however, very few and scattered. The assessment of enhanced land revenue is not very inducive to a popular participation specially because the enhancement in land revenue has no relaxation for any contribution that the people may make either in cash or in labour. The idea of a compulsory levy is possibly to assure a certain revenue return that can finance proper maintenance to the completed works. This idea may be applicable to sizeable works of over 50 acres irrigation capability that the P.W.D. regularly maintains. For maintenance of smaller works, increasing reliance could be placed on the beneficiaries who may come up in larger numbers to shoulder the responsibility of maintenance provided they have a different rate to pay. This differential may be varied from place to place depending upon the extent of financial relief that the local effort has finally resulted in both the construction and maintenance of the work. Individual merits will of course have to be taken into account, but even in the present arrangement the Revenue staff have to be watching the benefits from year to year and in case of tanks that breach, the wet land assessment is waived off.

MINOR IRRIGATION COMMITTEE ON HYDERABAD

SUMMARY

(a) Only 7 per cent of the cultivated area in the State has so far irrigation facilities. As much as 65 per cent of total irrigation arrangement is from tanks and canals. These are more popular in Telengana area while wells' construction is in vogue in the Marathwad and Karnatak portions of the State.

(b) The State has 35,000 tanks, the ownership of which vests with the Government. Some 13,000 tanks, having irrigation capability of 10 acres and less, are in the charge of Revenue Department, while the rest are with the P.W.D. Most of the technical guidance on Minor Irrigation constructions is provided by the P.W.D., as the Revenue Department has no engineering staff.

(c) A large number of tanks have been taken over by the Government consequent to the abolition of the old jagirs and estates. These have been neglected by the landlords for some years; hence tank repair is an outstanding item of expenditure on Minor Irrigation allocations.

(d) Standards for proper tank maintenance have so far been drawn only for 6,500 tanks. The P.W.D. staff will have to be considerably strengthened before standards can be laid for all the tanks in the State, on the analogy of what has been achieved in the neighbouring States of Mysore, Madras and Andhra.

(e) Responsibility for repair of tanks below 10 acres irrigation capability rests with the beneficiaries who have to pay enhanced land revenue upon the completion of work. Recently, however, a large number of breached tanks are lying unattended to. The land revenue enhancement has recently been relaxed on the ground of uncertainty of the water source. The beneficiaries have taken undue advantage of the relaxation and have continued to neglect their responsibility.

(f) The P.W.D. has been regularly attending to bigger tanks capable of irrigating 50 acres or more. On smaller tanks, the P.W.D. has been able to attend to only special repairs once in three years.

(g) Construction of water channels by Government has so far been limited to larger channels upto 3 cusecs water carrying capacity. Smaller size channels have to be constructed by the beneficiaries.

(h) The tempo of Minor Irrigation constructions reached its maximum in 1954-55 and is reported to have been maintained in later years.

(i) Well construction and installation of water lifting appliances have been popular in the Marathwad and Karnatak regions. In absence of steam or hydro-generated electricity, diesel-driven pumpsets have been gradually adopted.

(j) Surface water run-off quantity is capable of irrigating 9 million acres, but so far hardly 1·5 million acre irrigation has been effected. Consequently, there is good scope for irrigation expansion through utilisation of surface water particularly on Godavari and its tributaries. Construction of major, medium and minor irrigation schemes will have to be concurrently forged ahead for fuller utilisation of surface waters. Smaller schemes may continue to be undertaken because of their expeditious completion and almost immediate irrigation development.

(k) Maintenance of existing small water tanks may be organised even in the command of newly introduced major schemes because of their capability to meet with sporadic scattered irrigation demand. This has been the experience on Nizam Sagar where irrigation to paddy seedlings from small tanks is more handy than the running of long lengths of main channels with Nizam Sagar water.

(l) Lift irrigation from low lying stream water has not been popular so far because of non-availability of cheap electric power. For the present, only diesel operated lift irrigation could be attempted. This will have to be a cooperative endeavour, as individual water lifting will not be economical.

(m) Groundwater use has been encouraged by offering financial assistance to individuals for construction of open masonry wells. No systematic groundwater utilisation has been planned nor any technical service offered to individuals for fuller groundwater utilisation. Only top water bearing strata has been tapped on the open wells. Government need organise drilling operations and geophysical investigations with a view to delineating areas that are groundwater worthy. In the districts situated at the foot-hills of Western Ghats, regeneration of water supplies in springs and nalas could possibly be harnessed for irrigation even during winter.

(n) For sustained benefit from completed open wells, effective measures to maintain the ground-water recharge points need be taken; one way could be to gully-plug the nalas.

(o) The State is visited by cyclonic storms. As these storms greatly influence the design of the tanks, the Metereological Department should be requested for making out the path of the storms, so that all tank construction in this region should have adequate surplusing arrangement.

(p) No appreciable silting is observed on the tanks of the State. On the other hand, water evaporation losses are appreciable. Care is, therefore, to be taken in the selection of such sites where the water-spread is not extensive.

(q) The water depth requirement of paddy in the State is higher than what has averaged in Madhya Pradesh. This needs examination. Precise requirements for different types of soils and crops had better be outlined after carrying out experiments.

(r) Groundwater construction of water channels is at present restricted to those with a carrying capacity of 3 cusecs which means that channel constructions for as big areas as 200 acres have to be entrusted to the beneficiaries. This is not conducive to quick irrigation development. The State may examine the possibility of their constructing longer lengths of water channels, so that the portion left to the beneficiaries does not exceed 25 acres.

(s) Possibilities of constructing percolation tanks may be examined with a view to augmenting groundwater for irrigation relief during long periods of drought.

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(t) Construction of field embankments is at present restricted to soils of the light and medium texture. They should be particularly useful in encouraging dry farming methods in tracts where the soil is heavy and the monsoons are generally late. Prior to undertaking such constructions, studies need be carried out to the mechanics of different types of soils, so that the requisite texture is arranged for construction of such embankments.

(u) Technical staff, particularly of Supervisors and Overseers, has to be considerably expanded. Present arrangement for training Overseers and Supervisors may fall short of the requirement. Hence, possibilities may be examined for introducing short-term education and practical course in the special work of Surveying and Levelling.

(v) Capabilities of the slender staff could be considerably enlarged if they are rendered more mobile by providing them with jeeps.

(w) Full advantage of the working season during months of April, May and June (when the agricultural activity is minimum in the area) is not being taken at present. Funds and other sanctions are not available with the field staff till late in the season. Suitable steps need be taken to improve the procedure, so that all financial and technical sanctions are given in advance of the construction season.

(x) Maximum use of local resource and talent is in evidence on the individual efforts of the construction of wells and installation of pumping sets. Collective effort has, however, not been forthcoming on a large number of sizeable works. Cooperative endeavour at proper maintenance of the completed works is also lacking. It is for consideration if the formation of Panchayats exclusively of the irrigation beneficiaries would improve the standard of maintenance. Such Panchayats could be called "Irrigation Panchayats" and appear necessary, as a very small percentage of the rural population is at present interested in the irrigation works.

(y) Assessment of enhanced land revenue assures the finances that are required for proper maintenance of the completed works. This is particularly helpful in works that the P.W.D. is maintaining. For maintenance of smaller works, increasing reliance will have to be placed on the beneficiaries. Their contribution may increase if on such works a smaller increase in land revenue is fixed.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON MYSORE

(1) OUTSTANDING FEATURE

(i) In respect of irrigation requirement, the State of Mysore could be divided into three zones Western, Central and Eastern. The Western Zone comprises of Districts of Shimoga, Chikmagalur together with adjoining portions of Hassan and Mysore Districts. In the Central Zone are included Bangalore District, Mandya, eastern parts of Hassan and almost half of Tumkur District. The remaining District of Kolar, Chitaldurg and Tumkur would make up the Eastern Zone.

(ii) The Western Zone has a heavy rainfall ranging between 116″—300″. The Central Zone has rainfall varying between 20″—40″, but the Eastern Zone is relatively dry; at no place the rainfall is reported higher than 18″.

(iii) Rain-fed paddy crop is predominantly grown in the Western Zone. The soil is favourable for paddy cultivation, but plentiful rain water is quickly drained away as soon as there is a break in monsoon. There are consequently a few tanks in this Zone for meeting the irrigation requirement of paddy during monsoon break periods. As the monsoon break is usually for about a fortnight, the tank capacities in the Western Zone are rather small, measuring not more than 3-4 million cubic feet. Out of a total number of 25,000 tanks in the entire State, nearly 12,000 tanks are in the Western Zone, out of which as many as 8,000 tanks are reported to be in satisfactory condition.

(iv) In the Central Zone, the rainfall is not so plentiful; hence fairly big size tanks are noticed. They have pucca sluices and waste weirs. Usefulness of tank irrigation is recognised by the cultured and advanced people inhabiting this area. The tanks are generally in fairly good condition. There are about 5,000 tanks in the Central Zone. The soil in this region is clayee of medium texture and is considered fit for growing crops like cane, paddy, rabi, groundnut etc.

(v) In the Eastern Zone, there are as many as 8,000 tanks designed to conserve all available water. In addition to tanks, lift irrigation is extensively practised. Water lifting is done from wells sunk in the ayacut of the tank or by the side of a stream. Spring water near Devarsyadurga range of hills in Tumkur District has also been tapped for irrigation. The soil is rather light; hence soil erosion and silting of tanks is noticed in this area.

(2) IRRIGATION ON PERFORMANCE

(i) The break-up of 25,000 tanks in the State is as under:—

Western Zone	12,000 tanks
Central Zone	5,000 tanks
Eastern Zone	8,000 tanks

All these tanks are in the charge of the State Public Works Department. The work of restoration has been a foremost item of expenditure on Minor Irrigation funds. During the First Five Year Plan, 2,000 tanks were tackled in the Western Zone, some 3,000 in the Central and about 800 in the Eastern Zone. The restoration work in the Western Zone has been mainly for raising the embankments by one or two feet. In addition, sluices have been provided. In the Western Zone, not many tanks had sluices; hence their provision has to be done almost everywhere.

(ii) In the Central Zone, irrigation requirement on the tanks is fairly established. There has thus been a general clamour for increasing irrigation facilities to the existing tanks. The restoration work on some 300 tanks during the First Five Year Plan has mainly attempted at increasing the capacity of the tanks for catching surplus water available in the catchment.

(iii) In the Eastern Zone, the restoration work on about 800 tanks mainly consisted of raising the bund and weir for recouping the decline in storage capacity consequent to silting of the tank bed. In the Kolar District under the Palar Valley, so much heavy silting of tanks has taken place that out of 52,000 acres which were under irrigation in 1892, the area has now dwindled down to 35,000 acres. Desilting with machines was also attempted, but it proved very costly. It has been, more or less, established that the cheapest manner of spreading irrigation benefit would be to raise the bund and weir, though it may mean submergence of some dry land, for which compensation has necessarily to be paid.

(iv) The cost of restoration in different Zones has varied considerably. In the Western Zone, it cost only Rs. 50—100 per acre: on tanks in Central Zone it ranges between Rs. 200—300; but in the Eastern Zone it is costlier.

(v) Lift Irrigation has been most popular in the Eastern Zone where in one District alone of Kolar nearly 4,000 acres are under water lifted by pickotoes, kapilas and pumps.

(3) PROSPECTS

(i) There does not appear much scope for construction of new minor tanks with their present classification of cost not exceeding Rs. 10 lakhs. Increased irrigation can, however, be brought about by intensifying the scrutiny of irrigation performance on existing tanks. By suitably increasing their capacity, it should be possible to bring new areas under irrigation.

(ii) Wide-spread use of groundwater is not likely because of rocky sub-strata generally prevailing. No large-scale tubewell irrigation in the State seems possible. Limited groundwater lifting can certainly be attempted particularly in the Eastern parts where the rainfall deficiencies are rather chronic and detrimental to the surface water storage. Lifting of stream water has recently been attempted on Cauvery, where Government have installed electric pumpsets. Paddy irrigation alone is likely to work out costly. The overall working expense may be reduced if diversified agriculture is arranged by encouraging the cultivation of cash crops.

(iii) In a few areas, it may be possible to organise a coordinated use of surface and groundwater by permitting the construction of wells in the ayacut of storage tanks. The tank storage of water with satisfactory rainfall should have replenished the groundwater sufficiently so as to meet the irrigation requirement during dry spell when the storage in the tanks is depleted. For a corect forecast of likely benefit, it would however be necessary to examine the extent groundwater is recharged consequent to surface water storages.

(4) RECOMMENDATIONS

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(a) *Technical*

(i) Work of tanks restoration need be organised valley-wise, so that tanks in one river basin are tackled and all storages in that basin are properly taken care of. If this is not done, there is every danger of completed restoration being undone because others in the valley have not been attended to.

(ii) There appears scope for taking special measures that would hold up the fast rate of silting of tanks in Eastern Zone. The foreshore area of such tanks need be taken care of by leaving an uncultivated reserve belt of land. In addition, construction of check dams in the catchment area of large-size tanks may also be undertaken.

(iii) Construction of water channel is not complete in the command of several tanks with the result that irrigation water is not satisfactorily conveyed to all portions of the irrigation command. The Public Works Department in the State does not at present construct channels.

beyond 25 acres irrigatable area. In the interest of irrigation development, it may be desirable for the Public Works Department to undertake constructions of all channels that are likely to bring about expeditious irrigation relief.

(iv) There is an overall shortage of electric power in the State. In the interest of lift irrigation, it would be necessary to arrange for improved power availability. It is suggested that on all new installations for electrical generation the State may insist on a definite allocation of electric power for agricultural pumping.

(b) *Organisational*

(i) At present, all tanks have to be tackled by the Public Works Department in the State. The PWD staff, in spite of their best attempts, have not been able to handle more than 2,000 tanks during the First Five Year Plan. As the State has about 8,000 tanks to be restored, it would be important to strengthen the PWD staff. Possibility of posting one Superintending Engineer with the necessary organisation need be examined. In addition, the Public Works Department may be relieved of small tanks that have irrigation capability of 50 acres or below. For the restoration of such small tanks, the possibility of employing other agencies of Community Projects and Revenue Department may be examined. The Community Projects Organisation have invariably some technical hands on their staff. Further staffing of Revenue Department with technical hands may bring about a more expeditious restoration of tanks.

सत्यमेव जयते

REPORT OF THE MINOR IRRIGATION COMMITTEE ON ERSTWHILE RAJASTHAN STATE.

(1) OUTSTANDING FEATURES

The State of Rajasthan was formed in the post independence period by integration of former Rajputana States. The State, as a whole, lies in the arid zone of India. The annual evaporation from free water surface in the western region is much higher than in the rest of the country. During the summer the temperatures are high and dust storms are frequent. Due to arid condition and lack of vegetation, there is rapid radiation. The difference between the day and night temperatures is, therefore, too marked.

2. The rains generally start late in June but are sometimes delayed till July. The rainfall is scanty and erratic. The annual precipitation is less than 6 in. in the western region while it is about 15 in. to 18 in. in the central region. Even this meagre annual precipitation is below normal in 4 out of every 10 years. Under these conditions, even *kharif* cultivation is uncertain and no *rabi* worth the name is possible.

3. The eastern part of the State is interpersed with off shoots of Aravalli hills. Small streams that originate from these hills concentrate more on the eastern side where they flow into river Yamuna through its tributaries—Gambir and Chambal. The streams on the western side give rise to Lune river which passes into Rann of Kutch and finally into the sea. A few streams collect to form the famous Samber Salt Lake. The slopes in the hilly region are steep and run-off therefore, is quick and fairly abundant. The discharge in the streams however, lasts for a short period. Precipitation in the flat region is quickly dissipated by infiltration and evaporation. Surface run-off, therefore, is small.

4. Soil are grey and brown in colour with a fringe of red and yellow on the western side. In texture the soils range from black cotton type of Malwa to very sandy loam in parts of Jaipur, Jodhpur and Bikaner. The sub-soil layers are generally slightly heavier than the surface soil. The Vindhyans underlie the top formation of the strata. The depth of water table below the land surface and the thickness of the zone of saturation varies greatly from place to place.

(2) PERFORMANCE

5. *Wells.*—Wells have been an important item of minor irrigation. The surface water that is tapped at the wells is protected from the sever temperature conditions and is not so quickly effected by rainfall deficiencies as surface water storage area. Consequently utilisation of groundwater has been very popular. While increasing number of new wells have been constructed, a number of old wells have been repaired and the well bottoms of a good many have been deepened by blasting.

6. The initiative for such constructions is invariably taken by the well owners. Applications for such constructions, however start pouring in large numbers in the months of February and March when the cultivators notice lowering of water table on their existing wells and suddenly realise the limited possibilities of irrigation. These requests are thereafter examined and funds made available to the cultivators as promptly as possible to enable them to undertake the constructions in the following months of April, May and June. These months form rather slack period of agricultural activity—after the *rabi* harvest and before *kharif* cultivation is started. Every attempt is made to finance as many constructions as possible, but the rush of applications in a month or so does not give sufficient time for proper assessment of the applicant's request. Not frequently finances for new well constructions are required by new landholders that crop up consequent to fragmentation of family holdings. While one of the successors has the old family well with much too small an area for full utilisation of the water available at the well, other new landholders have no wells and most of them would ask for loan to enable individual ownership of a separate well. In quite a number of cases, wells are therefore constructed too close to each other with the result that water supplies are interfered with and reduced. Thus in spite of costly constructions, full utilisation of groundwater resources is not achieved.

7. Wells construction can hardly be completed in a year with only three months of working period between April and June. In fact, in the first year the cultivator is able to excavate upto the water table and just initiates irrigation of hardly an acre or two with the rather insufficient water supplies. He continues the construction in the second year and sometimes even in the third year. It would, therefore, be correct to anticipate irrigation progress of only 2 acres in the first year, 3 to 4 acres in the second year and 5 acres only in the final third year.

(3) IMPROVEMENT OF OLD WELLS

8. The work of well repairs and their deepening also suddenly gets into vogue only in the months of February and March when the effect of previous rainfall deficiency is noticed by the well owners. All the

applicants desire their wells to be deepened in the following months of April, May and June, the Agricultural Engineering Department which have so far only 13 Compressor units are unable to cope with the sudden rush of work. Quite a high percentage of well-deepening has consequently to be got done through private agency. The Government in such cases merely arranges for the storage and supply of requisite quantity of explosive material which is generally gelignite. Work by farmers, however, is rather protracted. For a more expeditious relief, it would be necessary to increase the number of Compressor units with Agricultural Engineering Department. It is understood that the Department is taking steps to bring the number to 35 against 13.

(4) WELLS IN DISUSE

9. Quite a large number of wells have been reported to be getting into disuse. No regular reports have been collected, but the estimated percentages of wells getting into disuse, have varied between 10 and 20%. The foremost reason for the failure of wells is the lack of sufficient groundwater replenishment. In some areas of the Udaipur Division, the groundwater slopes are pretty fast with the result that the storage is not sufficiently sustained. Construction of anicuts on streams should decrease the fast rate of groundwater outflow and thereby make available increasing quantities of water on the wells.

(5) WATER LIFTING

10. Water lifting is at present most popularly done by a Mote. At places with high water table, even a persian wheel is used, but all such water lifting is for irrigation of the owner's crops. At places where the water supply in the wells is surplus to the individuals requirement or is capable of being augmented, a pumpset installation could be attempted. Maximum running of the pumpset would, however, depend upon lift irrigation being extended to other farmers. Pumpset installations have been encouraged so far in the Jaipur and Udaipur Circles, but full benefit is at present not derived particularly on those that belong to small landholders. As suggested above, there is scope for cooperatives being organised for the pump operation and for the distribution of pumped water supplies.

(6) STATE LIFT IRRIGATION

11. Besides financing the purchase and installation of small pumpsets by individuals, the State has also attempted a few installations of large size pumps around Kotah. Water lifting is done from such pools in the streams that have a perennial water supply. These installation had so far to be run with diesel engines. The pumped water is, therefore, rather costly. The cultivators have been taking irrigation only to their

winter crop. Increasing use even during hot weather would reduce the overhead expense. Water pumping would become more economical when hydro-electrical supply is available from the Chambal Project.

(7) TUBEWELLS

12. Construction of irrigation tubewells has not been successful. Though quite a few individual farmers particularly in the Alwar District have been able to complete tubewells with 15,000—20,000 gallons per hour discharge. Success on tubewells has, however, been rather isolated. In Didwana and Pilani, tubewells with discharge around 20,000 gal. per hour have been completed, but so far no compact block has been delineated where economic water supplies can be made use of on sufficiently large number of tubewells. The Rajasthan Underground Water Board has been carrying out borings in the Jodhpur Division for individual farmers. Both the quantity and quality of water have been in doubt. At not many places sweet water in excess of 10,000 gal. per hour discharge has so far been located. Quite recently, the Exploratory Tubewell Organisation of the Ministry of Food and Agriculture has been carrying out exploratory drilling in the Jaisalmer and Bikaner areas at places selected by the Geological Survey of India. Results of exploration have not yet been compiled, but there does not appear much chance of extensive tubewell irrigation being adopted on the analogy of what has been possible in the States of Punjab, U.P. and Bihar.

(8) SURFACE WATER UTILISATION

13. In the Jaipur and Udaipur Divisions, surface water storages have been in vogue from times immemorial. Flashy discharges in the streams of Alwar and Bharatpur have been harnessed and spread over large cultivated tracts which had previously been completed with several miles of earthen embankments to hold up the water. Winter cultivation has been possible on fields that were spread with water from the flashy streams. The former Rulers of Jaipur and Udaipur had taken particular interest in the construction of large tanks. Similarly, jagirdars in these two Divisions have been encouraging the construction of tanks. For some years, however, the maintenance of these tanks was not attended to with the result that quite a high percentage had gone into disrepair. In the last three years of the First Plan, Rajasthan made serious attempts at repairing the breaches in the old tanks. At places where the tanks had satisfactory catchment area, additional earthwork was done for increasing the storage capacity and new water channels were taken out from the tanks that had satisfactory storage for irrigation. Initially almost entire effort of the Irrigation Department in the State was to repair and improve the existing tanks, but gradually new tanks are now being proposed. Most of the newly constructed tanks did not fill up completely. In 1956, the monsoon were satisfactory and this enabled some of constructed

tanks to get filled up for the first time. On all the storage tanks, new and those repaired, the main objective is to irrigate the winter crop and empty the tanks thereafter. On very few tanks, the stored water is sufficient to cater for hot-weather crop like sugarcane. This is very rarely possible. The evaporation losses in the summer months are so marked that complete utilisation of stored water on winter crops may be more advisable than attempts to carry any surplus over the dry months.

(9) FOOD PRODUCTION

14. Entirely new areas are cultivated with winter crops as soon as the storage tanks are completed. The entire irrigation command had previously no cultivation; hence the food production is appreciable consequent on arrangement of irrigation.

(10) PROSPECTS

15. Satisfactory surface water storage schemes may have to be restricted to areas which have sufficient rainfall and it may be desirable not to undertake construction of small storage tanks in tracts that have a rainfall lower than 10 inches. Even in other areas, it would be desirable to supplement the run-off by connecting a neighbouring catchment, so that the storage has good chance of being realised.

16. Irrigation from all such surface storage schemes will have to be mainly for the winter crop. Prospects of hot weather irrigation or chances of carrying over a surplus to the next monsoon are rather remote unless the heavy order of evaporation lossses is reduced by successful spreading of a mono molecular layer like the Cetyl Alcohol tried in Australia. So far Australia has been able to succeed in effecting a 30% economy by the treatment of Cetyl Alcohol, over a water spread of 2 acres. Feasibility of adopting this on larger water spreads is being tried in the country and the results thereof could be applied to the storage tanks in Rajasthan.

17. Besides direct irrigation from the stored water, some cultivation could be encouraged in the moist lands that are exposed consequent to a drop in the water levels of the tanks. This type of cultivation is called "bed cultivation" and is popular in Bharatpur area but could possibly be introduced on other tanks that have firm soil texture capable of retaining moisture. This is already receiving the consideration of the State first.

18. Yet another utilisation of surface water could be taken advantage of from the flashy discharge that several streams are reported to have. In area which have otherwise rather low annual precipitation, quite

frequent spates in the streams have been observed. It will be an advantage to divert these on to neighbouring land and try thereon to delay the run-off by the construction of embankments along contours. To some extent this is being tried in Alwar and its extension to other parts is being proposed.

19. On some streams in reaches that have impervious floors and sides, it should be possible to construct sub-surface dams. These should be of significant help in augmenting the groundwater supplies to the neighbouring area. Natural re-charge by influent streams can also be encouraged by building weirs. This would improve supplies to wells and bore holds along the stream courses.

20. Such methods of groundwater replenishment have not been so far popular possibly because they have no direct benefits. The extent of groundwater replenishment that these construction bring about has not so far been determined in a dry State like Rajasthan, it should be advisable to encourage such investigations that would bring out the extent of groundwater replenishment.

21. On all sub-surface water, economic manner of water lifting will be the completion of Chambal and the construction of transmission lines of the Bhakra system. more electricity should be available for agricultural pumping. The tract comprising the head-water reaches of the Chambal catchment particularly in Madhya Pradesh should need several lift irrigation arrangements. Suitable pumping sites may be located near the electric transmission layout planned for the power that would be generated on Chambal.

22. In larger tracts of West Rajasthan, the sub-surface water is highly mineralised. Some economic method of demineralising such quality waters will have to be evolved. The processes so far developed are much too expensive and are known to cost over Rs. 2,000 per acre foot.

(11) RECOMMENDATIONS

(a) *Technical*

23. For evolving improved design of engineering structures have to be arranged so far the State did not have much electricity in rural areas. With particularly those for the flood passing arrangement, it would be advisable to arrange for the installation of additional observation and recording stations. These should be so located as to furnish reliable data on the characteristics of the run-off for different types of catchment.

24. As groundwater may have to be increasingly relied upon for sustained irrigation benefit, it would be important to carry out systematic study of the water table fluctuations so that the groundwater re-charge and outflow conditions are known and reliable estimates can be made for the groundwater storage possibilities.

(b) *Organisational*

25. A study of the relative costs of construction has indicated that it is much cheaper to improve the existing wells than to construct a new well. Also because groundwater availability is not certain everywhere; it would be advisable to examine the possibility of improving the already tapped sources and making full use of the known supplies. For accelerated use of available groundwater supplies, cooperatives may have to be set up and special administrative steps taken to encourage extended use by a community of a water source, that is, at present owned by an individual.

26. The work of deepening of wells is at present tackled on receipt of individual applications. This does not always assure sufficient work for the compressor unit when it reaches a locality. Far too much time is used in transport and the average turn-out from a unit is low. If all work in a locality is organised in advance in one lot, a more economical and expeditious turn-out can be expected.

27. Heavy duty drilling rigs that originally belonged to Rajasthan Under Ground Water Board are at present with the Agricultural Engineering Section of the State. In order to make full use of the rigs the State may decide to encourage drilling work by offering loan and subsidy. At present, the rigs work on a no-profit no-loss basis. Quite a high order of expenditure has been averaging which is beyond the means of a large percentage of farmers.

28. The State has under consideration a proposal for handing to Panchayats the maintenance of small works that have irrigation capability of 50 acres and below. Early steps need be taken to complete the handing over. The Panchayats need be prescribed proper standards and rules and specification laid for efficient upkeep of the works. Descriptive pamphlets had better be prepared for the standard sections and approved procedure laid for maintenance. A periodical check may also be necessary by the local officer of the Irrigation Department. If such inspections bring out cases of continued neglect, the Irrigation Department may be authorised to undertake their rectification and to recover the cost incurred thereon from the Panchayat.

29. In respect of realisation of irrigation dues, it may be satisfactory to assess the irrigation rate on actual area irrigated. In a dry State like Rajasthan, it does not appear necessary to levy a fixed rate for the entire area that is brought under irrigation. The water requirement is so compelling that forecast irrigation returns must normally accrue. On small scattered works the Panchayats may decide to recover a water levy that would meet the recurring expenditure on maintenance of works which the beneficiaries are not skilled to carry out.

30. In regard to the bigger works that will be in the charge of the Irrigation Department, it would be important to entrust the measurement and assessment of the irrigation area to this Department. Satisfactory maintenance of works for sustained benefit is guaranteed if the agency carrying out the maintenance is made responsible for the assessment of irrigation benefits.

31. All irrigation on private works are assessed at enhanced land revenue against the next settlement operations. Till then an improved system of recording irrigation need be adopted for a more accurate information of the benefit that these works have brought about.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON MADHYA BHARAT

(1) OUTSTANDING FEATURES

Two systems of Chambal and Narbada look after the drainage of this State. Chambal and its large number of tributaries flow to the north, while Narbada in its east-west direction serves the extreme southern districts of Nimar, Dewas, Dhar and Jhabua. The most prevalent soil is that of black cotton except in the districts of Bhind and Morena in the north, where alluvium is observed. The annual rainfall varies between 30 to 40 inches. Nearly 94% of the total precipitation is observed during monsoon and the balance 6% during winter months. The rainfall distribution even during the months of monsoon is heavy in July-August but in September and October the average rainfall has been 6 in. and 1½ in. respectively. Rain showers in September and October coupled with the retentive nature of the black cotton soil enable extensive cropping during winter.

(2) IRRIGATION PERFORMANCE

In north Madhya Bharat, years back, large number of zamindars and jagirdars had built numerous tanks. In quite a number of these tanks, they still have the water rights on bed cultivation. In recent years, tank construction was mostly concentrated in the southern ryotwari parts of the State. Besides tank construction, financial assistance has been offered in the case of individual efforts of completing an open well, augmenting the well water supply by boring and blasting of its bottom installation of water lifting appliances including pumpsets. Out of a total irrigation of 90,000 acres from all the Minor Irrigation Schemes, the maximum contribution has been from construction and repair of wells. Irrigation area on Minor Irrigation Schemes has varied from year to year, but the best achievement seems to be in the year 1952-53, and there are good chances of this progress being maintained in the following years.

The relative cost of individual Minor Irrigation Scheme for every acre of new irrigation is as under:—

Rs. 270/- for constructions and improvement of tanks;
Rs. 150/- for construction and repair to wells;
Rs. 350/- for electrical pumping sets;
Rs. 600/- for oil pumping sets.

Except for the tank construction, all other schemes get ready for irrigation within 2 to 3 months. The time required for construction of a tank depends upon its size and varies from 6 to 12 months.

Implementation of Minor Irrigation Works has been the responsibility of the Public Works Department, the Revenue Department and the Agriculture Department in the State. In all tank constructions, PWD has a large part to play. Tanks costing upto Rs. 25,000 are the responsibility of the Revenue Department. The Revenue Department has, however, been seeking the technical assistance of the PWD in a large number of even the small-size tanks for the initial survey and design of new tanks. For the bigger tanks, the PWD is responsible for the survey, construction as well as maintenance. On the PWD tanks, irrigation rates are charged and credited to the revenue head in the State. All the operational expense on these works is, however, met by the State. In the case of smaller tanks which are in the charge of the Revenue Department, the maintenance responsibility is that of the beneficiaries. While the Revenue Department gets the normal maintenance done by the beneficiaries, for special repairs (particularly to the masonry portion of the works required skilled attention), PWD has to carry them out with the special financial allocation that the Revenue Department makes available to the PWD.

The State has approved of a betterment levy being realised even on Minor Irrigation Works, but there is no provision for a differential being applied on such works that are completed with popular contribution in cash or of labour.

The area that is irrigated on the large-size tanks being maintained by the PWD is accurately recorded from season to season. In regard to the Irrigation achievements on other Minor Irrigation Works of wells, deepening of wells, pumping set installations, the benefit is recorded on the basis of irrigation potential that was initially forecast. The State proposes to enhance the land revenue on the irrigated fields at the time of the next Settlement. Meanwhile, the only indication of actual irrigation on completed works can be had out of the annual survey of cropped area that the village Patwari carries in normal routine work.

(3) PROSPECTS

With the construction of large storage on Chambal and old works of the Gwalior State, quite satisfactory irrigation relief could be afforded to the northern parts of the State, but neither the central plateau nor the Narbada basin would have any major work. Irrigation relief in these two areas may, therefore, have to be afforded by large scale activity on Minor Irrigation.

Surface water storages could be taken up at suitable sites, but in districts like Jhabua the area is badly in need of soil and moisture conservation through the construction of contour bunds.

Prospect of plentiful groundwater is rather scanty except in the two northern districts of Bhind and Morena which have alluvium deposits of Jamuna. Even in these districts, the groundwater supply may not be as abundant as in the States of Punjab, U.P. and Bihar, where State tubewell irrigation is in vogue. Moreover, a high percentage of the area in these two districts would be receiving gravity flow from Chambal. The best chances of obtaining relatively improved supply of groundwater on open wells are in the districts of Nimar and Mandasor. In these two districts, the construction of open wells could be increasingly encouraged.

Lift irrigation from streams has some chances only when cheap hydroelectric power is available instead of the diesel running that has previously been tried with not much success. Further the perennial source of water supply can be had only on the major rivers; hence all attempts at lift irrigation will have to be in areas where these two conditions are satisfied. There are good prospects of lift irrigation being popular in the Narbada basin.

(4) SUGGESTIONS

(a) *Technical.*—Increasing attention need be given to the construction of water channels to all portions of the command on the completed tank. Requirement of irrigation water has so far been only occasional when there is a deficiency in rainfall. During such breaks in monsoon, the intense irrigation demand can be met only from an already completed water channel.

The water depth requirement of different crops needs a review, as at present rather excessive quantities are being used. Such use of water may result in drainage difficulties in the heavy type of soils that prevail in the State.

In the design of tanks, there is scope for selecting such constructions that have lower order of water-spread, so that the losses from evaporation are minimized.

As tanks are increasingly constructed, it will be desirable for the PWD to lay out definite standards for all completed tanks. Such standards would be a good guide to all the agencies that are entrusted the responsibility of tanks maintenance.

To prevent the open wells from getting into disuse, it would be important to adopt methods for satisfactory groundwater re-charge. These can be done both by gully-plugging the nallas as also by the construction of bunds that would conserve the rain water.

It is important all pump installations are financed only from such wells where the groundwater availability has previously been examined.

(b) *Organizational.*—As increasing number of tanks would be entrusted to the charge of the Revenue Department and the Panchayats, it would be desirable to staff them with technical hands. The present arrangement of referring individual difficulties to PWD may not be satisfactory in the long run. It is, therefore, recommended that immediate steps may be taken to arrange the staff which, to start with, may comprise of only Overseers and Assistant Engineers. It would be advisable to obtain this staff on deputation from the regular PWD. This would open chances for their promotion.

Maximum availability of labour in the rural areas is observed during the months of April, May and June after the harvesting of rabi and prior to sowing of kharif. In this slack period of agricultural activity, it may be possible to get large strength of labour for maximum construction of works. So far, seasonal availability of labour has not been made full use of because of lack of funds at this time of the beginning of financial year. It is suggested that a procedure may be evolved which may make available necessary funds and sanctions well in advance of this period.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON MADHYA BHARAT

SUMMARY

(1) Tank construction has been popular in the southern ryotwari parts of the State. The most popular item of Minor Irrigation has, however, been the construction and repair of wells. This is also the cheapest construction for an acre of new irrigation.

(2) Though the construction of tanks costing less than Rs. 2,500/- is the responsibility of the Revenue Department, the P.W.D. is required to carry out the initial survey and preparation of estimate. Normal repairs to such tanks are got done by the beneficiaries, but for special repairs the P.W.D. is required.

(3) Irrigation benefits on tanks constructed and maintained by the P.W.D. are recorded from season to season. Reports of irrigation achievement on other Minor Irrigation works are on the basis of the irrigation potential that was initially forecast.

(4) Irrigation works need be planned in the central plateau and in the Narbada basin where no major work has so far been undertaken.

(5) Jhabua District needs soil conservation measures.

(6) Construction of open wells should be encouraged in the Districts of Nimar and Mandsor.

(7) There are good prospects of lift irrigation being popular in Narbada basin with cheap hydro-electric power being available.

(8) Construction of water channels need be insisted for accelerated irrigation development.

(9) Excessive water is at present being used on different crops. This may result in drainage difficulties particularly in the heavy type of soils. Precise requirements of water need be determined.

(10) Standards need be drawn by the P.W.D. for proper maintenance of completed tanks.

(11) Groundwater supplies to open wells need be protected by proper care of the nallas.

(12) All financial and technical sanctions for the P.W.D. works need be arranged in advance of the working season (between April and June) as maximum labour is available in the rural areas during these months.

(13) Possibilities of staffing the Revenue Department and the Panchayats with technical hands may be examined.

सत्यमेव जयते

REPORT OF MINOR IRRIGATION COMMITTEE ON VINDHYA PRADESH

1. Outstanding Features:

The State of Vindhya Pradesh which appeared on the map of India as a result of integration of numerous small States of the former Central India, comprises 2 historical regions, Bundel Khand in the west and Baghel Khand in the east. The former included districts of Datia, Tikam Garh, Chattarpur and Panna, while the latter comprises districts of Rewa, Satna, Sindhi and Shadhel. The whole State is traversed by series of upper Vindhyan system, which generally run from south-westerly to north-easterly direction. These ranges are responsible for origination of 5 tributaries of river Ganges namely; Betwa, Dhasan, Kon, Tons & Son which flow between the ridges more or less in the same north-easterly direction. Because of a number of ridges and cross-ridges, the whole country is mostly undulating and patches of flat lands are rarely found. The portion of Bundel Khand region lying west of Panna series of the Vindhyas is comparatively flat.

(ii) The average normal precipitation in the State is about 40 inches in the year ranging from about 32 inches in the west to about 55 inches in the east. Almost the entire rainfall in the State is contributed by the south-west monsoons, a major current of which comes in the north-westerly direction from Bay of Bengal. This direction of monsoon current and congregation of hilly ranges towards the east of the State, account for the larger precipitation on the eastern side. While the maximum precipitation is consistently experienced in the months of July and August, the normal rainfall in the month of September also is of the order of 5 to 7 inches. Quite frequently, there are showers even in October and the normal rainfall in the month averages to about 1.5 inches.

(iii) The various small tributaries which originate from hilly ranges in the State, are generally flashy, *i.e.,* they are in spate in July and August but thereafter the supplies decline with the result that the perennial discharge all the year round, is generally observed only in the main tributaries in their later stages when they have developed sufficient catchment areas in their foreshores. The rivers in the State, being in their early stages, have generally steep slopes and before they enter the flat regions, they are out of the State territory.

(iv) The soils of Vindhya Pradesh rest mostly on sand stone of the Vindhyan Series almost free from trap. They are generally mixed black and red soils, varying from region to region in proportion, texture and fertility. In general, the soils in Baghel Khand are heavier and more suited to paddy cultivation while soils in Bundel Khand are more suited to rabi cultivation. Shallow gravely red soils of poor quality and full of kankars, are frequently met with and on such soils cheap crops like kodo, inferior type of Bajra and Jawar are produced.

(v) The cropping pattern is based on the rainfed conditions and varies according to nature of soil and magnitude of rainfall. Generally speaking, more intensive cultivation is noticed during kharif. The cropped area in rabi is relatively smaller though efforts have been to extend the benefits of the rainfall to the rabi season by suitable moisture conservation measures in the form of construction of temporary and permanent bundies. In Baghel Khand which is subject to higher rainfall, paddy occupies a prominent place with a high percentage of 30 to 50 per cent of the net area sown. Wheat is more prominent crop in the western part of the State. Growing of wheat and barley under well irrigation is widely prevalent in the State.

(2) IRRIGATION PERFORMANCE:

(i) Vindhya Pradesh is yet in infancy of its irrigation development. Though natural and rolling topography of the State presents ample scope for utilisation of surface water resources, yet much attention does not seem to have been paid to irrigation by the former small individual States except, to some extent, in the districts of Bundel Khand. The total irrigation from the tanks in the pre-integration period was of the order of 15,000 acres which worked out to less than ½ per cent of the net area sown of the State. The position of groundwater utilisation, however, has been comparatively good. Individual efforts at well construction had resulted in a total of 60 to 70 thousand irrigation wells existing in the State at the time of integration and contributing to irrigation of as much as 1,75,000 acres. This brought the total figure of irrigation in the premerger period to 1,90,000 acres, *i.e.*, about 5 per cent of the net cropped area. The maximum surface as well as groundwater utilisation was in the districts of Tikam Garh and Chattarpur of Bundel Khand which had irrigation facilities for an acreage of 22 and 15 per cent. of the net cropped area respectively. The irrigation arrangements in the remaining districts took care of an acreage ranging from .15 to 3.0 per cent only of the net cropped area.

(ii) The development of irrigation in the State on a sound and systematic footing was taken up for the first time during the period of First Five Year Plan when an Irrigation Wing of the P.W.D. was organised. Aided with this new set-up, the State undertook surveys, planning and construction of surface water schemes such as tanks, weirs and canals and thus extended its Minor Irrigation programme beyond construction of wells and installation of improved appliances for lifting water from the wells, through grant of loans and subsidies to private agriculturists. Repair and renovation work to the old existing tanks, was also undertaken from the G.M.F. funds available under the extension and improvement. Alongside Minor Irrigation works, the State also contemplated to undertake some medium and major schemes.

(iii) The effective progress of irrigation achievement in the First Five Year Plan, however, has not been very bright. Out of a total of 27 Minor Irrigation Schemes for tanks and weirs (including 6 schemes for bundies) undertaken during First Five Year Plan with estimated cost of Rs. 60 lakhs and irrigation potential of 40 lakh acres 10 schemes including 6 bundies schemes were completed during the plan period. The total irrigation that have actually materialised on these schemes is reported to be only 4,000 acres. The chief cause for this slack progress has been the initial set-back suffered by the irrigation programme of the State due to a large number of difficulties experienced in organising its activity almost from a scratch and in the face of acute shortage of technical personnel. Though the State made a start with one irrigation Engineer in the year 1952, it was only in March 1954 that 3 divisions on P.W.D. lines could be established in the districts of Rewa, Tikam Garh and Satna. Even after the formation of these divisions, much difficulty is said to have been experienced in recruiting of full strength of overseers and Draftsmen and getting contractors for execution of works. Contractors working in adjoining States are reported to have been persuaded to take up work in the State. Actually speaking, it was only in the last year of the First Five Year Plan that some reasonable tempo of irrigation construction was attended in the State.

(iv) The schemes of well construction or installation of lifting appliances, have been tackled mostly through individual efforts. Financial assistance granted as loans and subsidies has been responsible for construction of 600 new wells and installation of 120 persian wheels and 120 pumping sets on the wells, while quite a larger number of wells are reported to have been constructed as a result of purely private contribution. The number of wells in disuse has also reduced from 3867 in 1949-50 to only 50 in 1954-55 as a result of individual efforts. No large size water lifting from streams has so far been attempted by any cooperative or State organisation. The State Irrigation Department is, however, provided with necessary equipment for boring of wells.

(v) The relative cost per acre for completing different types of Minor Irrigation Schemes works out to Rs. 200/- to Rs. 300/- for Storage Schemes; Rs. 100/-, to Rs. 150/- for diversion schemes; Rs. 100/- to Rs. 125/- for bundies and Rs. 200/- to Rs. 400/- for new wells. The cost of boring of wells works out to Rs. 80/- per foot of boring for 10 feet diameter bore and Rs. 40/- per foot for 5 feet diameter bore.

(vi) Time for completion for different types of Minor Irrigation Schemes would actually depend upon a number of factors and varies from scheme to scheme. Generally speaking, a diversion and storage scheme may require a year to two years for completion whereas a well completion 6 months and installation of water lifting appliance and boring of well about 3 months.

(vii) The development of irrigation benefits on wells etc. is immediate. On other Minor Irrigation Schemes also, it has been quite satisfactory on completed schemes, there has been though some difficulty in proper distribution of supplies from the water channels due to lack of proper outlets and water courses and irresponsible cutting of the channels by irrigators in the absence of any positive enactment in this regard. Normally speaking, however, it is not likely to take more than one year to attain full irrigation benefits on all Minor Irrigation Schemes.

(viii) The maintenance and operation of wells is the exclusive responsibility of the private agriculturists who own the wells. On the other hand, the maintenance of new Minor Irrigation Schemes that are now being completed by the State P.W.D. is the complete responsibility of the P.W.D. Besides, the new works, the maintenance of about 250 old tanks (most of which are located in the districts of Tikam Garh and Chattar Pur of Bundel Khand) with variable irrigation capabilities ranging from less than 50 acres to more than 100 acres is also with the P.W.D.. The latter has, further been contemplating to undertake responsibility of renovation and maintenance of another 150 tanks which are located in various districts and are likely to irrigate more than 100 acres each after repairs.

(ix) The P.W.D. assesses the actual irrigation done on each new and old scheme under its charge. The irrigation rate is assessed on the basis of the crop that matures. The approved rate per acre for flow irrigation for different crops varies from Rs. 10/- for sugar-cane and Rs. 6/- for paddy, wheat and vegetable etc. and Rs. 3/- for gram and masoor etc. These rates are for new areas brought under irrigation from new shcemes now being implemented. The corresponding rates for old area from old schemes are Rs. 6/- for sugar-cane and Rs. 4/- for paddy, wheat and vegetable and Rs. 2/4/- for gram and masoor etc. The rates for lift irrigation from surface water are half of the flow rates. A separate rate of Rs. 4/- per acre for the new works and Rs. 3/- per acre for old works is levied on rabi cultivation of emerged area in tank bed which results, due to depletion of supplies.

(x) The irrigation rates levied are low compared to other States and not even sufficient to pay the interest charges on the capital cost, maintenance expenditure being additional. No irrigation cess is realised in addition to irrigation rates. The State Government has also been hesitant to impose any betterment levy due to the fact that irrigation was just being introduced in the State and the benefits were yet to be felt by the people and also that such levy may hamper the quick development of irrigation in the State. The State being agriculturally backward and because of other factors such as average land-holding being high and cultivators being content with cheap rainfed crops, there is already not much incentive for irrigation. No contribution either in cash or labour is being received from beneficiaries in the construction of new works. Large scale ground water utilisation by wells is, however, an outstanding achievement of popular contribution.

(xi) The assessment of irrigation benefits on wells is made by the revenue staff during their normal duties of recording the various crops under their charge. The State, however, has no instrument to enhance the land-revenue on well-irrigated area till the next settlement takes place.

(3) PROSPECTS:

(i) The source of surface water in the State is rainfall, a major proportion of which is received in a brief span of three monsoon months namely, July, August and September. It is, therefore, important that any plans for large scale and extensive utilisation of surface water in the State are essentially based on water storage projects. Fortunately, the hilly and undulating topography of the State is eminently suitable for surface storage schemes.

(ii) While the schemes for diversions, weirs and channels may also occasionally be possible on reaches of streams having larger catchment areas, any wide scope for such schemes does not exist due to generally short spell of supplies in the streams. In fact, there is almost no scope for diversion schemes on small streams with small catchments because the period of flow is very short-lived in these streams and moreover it synchronises with the rainfall in the irrigation tracts when there is little demand for irrigation water. Such streams cannot, therefore, be depended to meet the irrigation demand which mainly arises due to deficiency or irregularity in rainfall.

(iii) Due to predominantly hilly terrain of the country, specially in the Baghel Khand region of the State, any vast stretches of flat lands are rarely met with. Such a topography is more suited to minor and medium sized irrigation schemes. Though the major schemes may also be possible, they would every time require large compact areas of flat lands which are few. Chances of linking up irrigation schemes with hydro-electric generation are also sparse nor are such schemes expected to be controlling floods. So the schemes must depend exclusively on the irrigation areas for their economic performance.

(iv) The irrigation demand for water under the prevailing popular cropping pattern arises only either in early July for sowing of paddy, in case of a break in monsoon, or in late September and October for maturity waterings of paddy and sowing of rabi in case of early withdrawal of monsoon. Of course, there is also some demand specially in Bundel Khand region for irrigation water in middle or late rabi. In view of this type of requirement, which must persist in the initial stages of irrigation development, the major schemes—wherever possible—will have better economic prospects at a later stage when agricultural activity has developed to extend all the year round and to require carryover of water storage capacity from one year to another. The prospects, therefore, are that in the immediate future the minor and medium irrigation schemes would be taken up in larger number followed up in due course with major schemes as well. Of course, the feasibility of each type of scheme has to be examined for the particular features of a tract. There are places where only minor irrigation schemes can be constructed, while there are others where major and medium ones are feasible. The situation in each case would decide the issue.

(v) Out of a few deabs of large stretches available in the State, one such deab between rivers Sind and Pahuj covering district of Datia has already been included in the command of Bhander Canal which is being projected by the Government of Uttar Pradesh to be fed from new Mata Tila Reservoir. This canal will bring irrigation to about 60,000 acres in district of Datia representing about 30 per cent of the total culturable area available in the District. After these supplies are available, there would be left little scope for further development of irrigation in this part of the State.

(vi) Due to presence of consolidated rocks in the sub strata varying from granite gneiss in Bundel Khand to quartzitic sandstone of Vindhyan ranges in Baghel Khand, the groundwater availability in the State does not present any bright prospect. Saturation zone of groundwater in such regions much necessarily depend upon the presence of joints, fissures, fractures and faults etc. and, therefore, the groundwater supply varies from region to region and cannot be profused anywhere. Comparatively speaking, granitic rock of Bundel Khand with relatively thicker and more porous soil cover presents more scope for ground-water development than the quartzitic sandstone of Vindhyan ranges which is compact and has little porosity. Further there are greater chances of getting more assured supplies near the basins of perennial streams after they enter comparatively flatter country. Such scope also is provided more by Dhasan River because the other rivers pass only through the hilly terrain within the State territory.

(vii) As the groundwater supply is generally scanty, groundwater lift will not be able to sustain a continuous running of any lift appliance.

Installation of power pumps on wells, therefore, does not have much scope. The scheme for distribution of diesel pumps will, however, continue to be popular on a small scale for facilitating water lift and due to other economic reasons. The installation of persian wheels in preference to old crude appliance for water lifting should however have a fairly good scope.

(viii) Occasional pumping on streams should be possible particularly in their later stages which have perennial supplies for larger part of the year. These schemes will, however, be more popular and have better economic prospects when cheap electric power is available and the irrigators have learnt to make economic use of the costly lifted water.

(ix) Small schemes of paddy and rabi bundies will continue to be popular in the State because of the prevalent favourable topography. Such schemes are generally quite cheap, emanable to private enterprise and useful inasmuch as they protect paddy cultivation and sowing of rabi against vagaries of rainfall.

(x) The ultimate potential of irrigation development in the State will actually depend on the land resources rather than water resources because the latter are quite in abundance while the former are lacking. It is estimated that by the end of Second Five Year Plan, the State will have developed an irrigation potential of nearly 1·5 to 2 lac acres through the combined major, minor and medium irrigation schemes for surface water utilisation executed by the end of the Plan period, including 60,000 acres that will be irrigated from Bhander Canal in Uttar Pradesh. Ground-water development during the Second Five Year Plan should also contribute to an additional irrigation of about 30 to 40 thousand acres. This should bring the total irrigation potential at the end of the Second Five Year Plan to nearly 4 lac acres. There will still be left quite ample scope for further development of irrigation. The ultimate practicable irrigation potentials which should not be difficult to attain through proper coordination of surface water and groundwater exploitation in course of another 10 to 15 years, is considered to be 8 lac acres *i.e.,* about 20 per cent of the cultivated area.

RECOMMENDATIONS

(a) TECHNICAL

For proper and well-planned utilisation of surface water resources, it is essential to collect hydrologic data regarding the precipitation, run-off floods and losses from evaporation and seepage. Due to irrigation especially the surface water irrigation, being new in Vindhya Pradesh, it is not possible to draw upon any past record of observations. Though rainfall data is available for important towns, any reliable information regarding stream-flow is lacking particularly so in Baghel Khand region.

It is, therefore, important that gauge points should be set up all over the State for accurately determining the stream-flow and run-off factors for the catchment.

(ii) In the absence of any established relationship between catchment areas and yields, the State has been depending upon a thumb rule namely that one square mile of catchment will yield 25 million cubic feet of storage. The thumb rule is based on Strang's table which gives the corresponding yield from an average catchment with a monsoon rainfall of 35 inches. Actually because of variable topography and rainfall in Vindhya Pradesh, it is likely that run-off factor will be more for Baghel Khand region as compared to Bundel Khand region. The irrigation research station of Uttar Pradesh has evolved certain formulae regarding yields from a catchment in Bundel Khand in U.P. These formulae are reporduced below:—

Serial No.	Type of Catchment	Formulae recommended
1.	Steep bare catchment with hills.	Run-off: 1·2074 (rainfall—12·95 in.).
2.	Hilly catchments covered with forests.	Run-off: 1·012 (Rainfall—13·36 in.).
3.	Plain catchments.	Run-off: 0·5818 (Rainfall—14·23 in.).

Till the State collects sufficient hydrologic data and is in a position to prepare hydrographs for its particular conditions and obtain more positive and reliable results on the basis of these, it should make use of the above formulae as far as Bundel Khand region is concerned. Slightly higher figures for yields of catchments should, however, be adopted for the Baghel Khand region, in view of its having better catchment.

(iii) For estimation of maximum flood discharges, which is an essential pre-requisite to the design of a storage scheme, the State has been depending on Dicken's formula namely Q:CM where 'Q' is the discharge in Cusecs, 'M' is catchment in square miles and 'C' is Co-efficient varying from 150 to 1,000 or more. Though the choice of formula is correct (bacause out of the existing formulae, Dicken's formula is better suited for catchment in Northern and Central India), yet because of variable range of efficient in this formula, it is difficult to make a realistic choice of the value of 'C' in the absence of any previous observations being available. The State has earlier adopted a value of 'C' equal to

600 in some projects for example Teherka Canal Scheme in Bundel Khand. This value is considered to be on the low side. On the basis of observations, Beala has recommended the use of 1,000 to 1,400 as co-efficient for Madhya Pradesh. This value is considered more realistic for the type of catchment in Vindhya Pradesh and should be adopted in future projects unless some more authentic or reliable data is available to warrant a change.

(iv) Catchment area being generally sufficient in Vindhya Pradesh, storage capacities of reservoir should be determined according to the water requirement for the proposed irrigated area and cropping pattern making proper allowances for losses of water from the reservoir and the distribution system and loss of storage by silting. In absence of any past experience observation of factors involved, State had previously been adopting a uniform overall duty of 15 acres per million cubic ft. of storage and designing the storage capacities on this basis, making an extra allowance of 10 per cent for silting. Later on this duty was increased to 20 acres per million cubic ft. on the basis of figures adopted in adjoining States. This duty may or may not be realistic and should in any case vary with the irrigated crop pattern. For predominant monsoon rice irrigation (in Baghel Khand) it should be possible to do with less storage capacity because of simultaneous replenishment that would be available. State should, therefore, initiate forthwith a detailed study of the factors involved and meanwhile make use of the investigations carried out in adjoining similar areas. Sir Cland's formula for rate of silting given below, have been found to hold fairly for Bundel Khand catchment. Use can be made of this.

S : C A

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A : Catchment area in square miles.

C : a co-efficient which is 0·5 for rocky catchments 1·7 for normal catchments.

5·5 for soil catchments.

Similarly the results of actual observation of monthly losses on existing reservoir in Bundel Khand can be made use of in computing losses for new projects.

(v) Alongside survey for surface water resources, there is also need to tackle groundwater utilisation in an organised and systematic manner. As the groundwater conditions are not favourable, it is all the more essential that further constructions of wells are planned properly in areas which have better recharge conditions so that over-drafting from any groundwater reservoir is avoided. As the chief source of all surface water and groundwater is precipitation, it is likely that envisaged intensive water storage programme in the State may influence, to some extent, the groundwater conditions in some regions and so can the water conservation schemes. It is, therefore, important to conduct proper surveys and have proper knowledge regarding groundwater hydrologic conditions in the State and to co-ordinate groundwater utilisation, with water-storage and conservation schemes. Care has also to be taken to protect all the places of recharge.

(vi) During some years of the Ist Five Year Plan subsidy to the extent of 25 per cent of the total cost had also been granted in addition to the loan, for private schemes such as construction of wells and distribution of pumps and rahats. These schemes for groundwater utilisation have been fairly popular among the cultivators and it is considered desirable that grant of subsidy on these schemes should cease in future.

(vii) As the groundwater utilisation will mostly depend on private efforts, it is essential that there must be an advisory unit both for advising cultivators about the suitability of sub-strata and to control the over draft from any particular region. This unit will also make available to the cultivators the materials, and equipments for deepening and boring of wells that would enable the maximum utilisation of groundwater.

(viii) According to the statistical record available there are about 9,000 old tanks in Vindhya Pradesh. Though the most of these will be domestic tanks without any irrigation benefits, it is estimated that there will be about 1,000 tanks which can be developed with proper repairs into irrigation tanks with capabilities ranging from 1 to 100 acres. The undulating topography provides ample further scope for construction of small sized tanks of irrigation capabilities less than 100 acres. It should be possible for the State to undertake the renovation work of these old tanks and construction of more small tanks through the agency of Community Project Organisation which can harness the private contribution on a large scale for these small works. The State P.W.D. may lay down proper standards for construction and maintenance of these small tanks so that the works through proper contribution can, by conforming to these standards ensure technical soundness of the works.

(ix) In order to achieve accelerated utilisation of water made available from the various schemes, it is important that the distribution system including the position of outlets and water courses are planned out and constructed in the first instance before the scheme is put into commission. Efforts should also be made to evolve a cropping pattern that would make fuller use of irrigation facilities and to induce the cultivators to make use of improved agricultural and irrigation practices. A great deal of investigations and demonstrations are necessary for bringing home to the cultivators the benefits of new improved practices. National Extension Services should lay greater emphasis on this aspects of irrigation.

(b) Organisation

(i) A development of irrigation on an organised basis is being planned in the State for the first time; there is need for carrying out extensive surveys and investigation works for new schemes. The jurisdiction of the 4 existing irrigation divisions of the State with headquarters at Tikam Garh, Satna, Rewa and Sadhol covers the entire State and it should be possible for these divisions, after proper staffing, to carry out the survey and investigation works more conveniently in their respective areas, in addition to construction and maintenance work in their charge. In regard to groundwater utilisation, the Advisory Unit of the State should be staffed with Geologists and Hydrologists who should have, in course of time, an intimate acquaintance with the surface geology and groundwater hydrology of the State. Boring and other equipment, to be made available to the cultivators for improving groundwater supplies, should be under this division.

(ii) The State has hitherto experienced a great difficulty in recruiting its full strength of technical staff. The strength of the Engineer Officers had been made up partially by direct recruitment, partially by officers on deputation from other States and also by re-employment of retired officers. There had, however, been great paucity of officers. The State has now established a Government Polytechnical Institute at Nowgong which expects to turn out about 30 qualified Overseers every year. As a result of this, the existing shortage of Overseers is expected to be made up in about a couple of years.

(iii) The shortage of technical staff is further aggravated by the lack of adequate transport arrangements. Engineer Officers below the status of Executive Officers have not been provided with landrovers or jeep cars. It is felt that the provision of jeep cars or landrovers to the Assistant Engineers also will add to the efficiency of the existing staff and result in larger turn-out and quicker execution.

(iv) The survey and investigation work as well as the construction work in stray and odd places in the Irrigation Division of the State makes the life of the Technical Staff in these divisions harder than that in the Buildings and Roads Division. There is, therefore, reported to be a tendency among the staff to prefer employment in the latter division of the P.W.D. It will, therefore, be desirable to sanction some special allowances to the Overseers on the lines of the Irrigation Department in U.P. which pays allowance of Rs. 30 per month in lieu of harder life. The Irrigation divisions in the State have at present been functioning on the lines of the Central P.W.D. where financial powers delegated to the officers for contracts and disbursement in general are very limited. Due to nature of irrigation works being different, limitation of powers has been partly responsible for delay in the execution of schemes. It will, therefore, be desirable to relax the limits of these powers on the lines of irrigation division in other States.

(v) No contribution in cash or labour has been noticed. The irrigation rates levied are not enough to meet the maintenance cost as well the interest on the capital cost. Because of the new start that the State has made on irrigation it may be desirable for the State to shoulder the responsibility for both the construction and maintenance. The State, may, therefore, defer the betterment levy on minor irrigation schemes and also continue to provide a relaxation in the irrigation rates. A start on the public reliance should, however, be made by entrusting the maintenance of small works to the irrigators through the agency of C.P.A., and also by encouraging them to take up construction of small works.

(vi) The State at present has no irrigation enactments with the result that difficulties are felt in the distribution of supplies and also the irrigation works are sometimes tempered with irresponsibility by the irrigators. It is essential for the State to expedite comprehensive irrigation enactments on the lines of other State which have more advanced development in irrigation.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON PEPSU

(1) OUTSTANDING FEATURES.

The State was formed consequent to integration of several principally States; hence the State boundary is not compact. The general ground slope is from north-east to south-west except for the Mohindargarh area where the slope is from south to north. Rainfall varies sharply from 30 inches in the hilly areas of the north to only 10 inches in the extreme western portion of the State. Gravity flow canal systems from the two rivers of Sutlej and Jamuna serve most area of the State. The soil is light in texture. The geological formation in the State is alluvium. Groundwater is available almost everywhere though for abundant groundwater supplies only the northern portions could be depended upon.

(2) IRRIGATION PERFORMANCE

Maximum irrigation benefit to the State has been brought about by the two gravity canal systems of Sirhind and Western Jamuna Canal. New channels from the Bhakra canal system have also added to the irrigation facilities and water supplies by gravity are expected to improve further after the Bhakra Dam is completed. The Minor Irrigation schemes have consequently been primarily undertaken in areas that cannot be irrigated by the above canal systems. Some times these have been completed with a view to meeting the keen irrigation demand for more intensive cultivation than what can be coped with by the canal water supplies.

The most outstanding contribution among the Minor Irrigation schemes has been by the use of groundwater from open wells as well as tubewells. In the northern hilly region of Nallagarh and Kandaghat, some construction of kuhls has been undertaken. In the Mohindargarh area, construction of wells has been tedious and costly. The Exploratory Tube-Well Organisation of the Ministry of Agriculture is carrying out drillings in this area for determining the groundwater availability. So far abstraction of abandoned groundwater supplies at economical rates has been found only in the north-eastern Districts of Kapurthala, Phagwara and Patiala. Consequently 625 tubewells have been constructed for State tubewell irrigation in such areas of the State that are either not commanded by the gravity canal system, *e.g.* Malerkotala and Derha and areas in the Sirhind Canal system, or where the water table is too high, *e.g.* the Kapurthala area where the Bist Doab Canal Extension was not considered advisable in view of the high water table.

Besides State tubewell irrigation schemes, large number of private tubewells have been constructed with financial assistance received under Minor Irrigation allocation of the GMF Campaign. The Agricultural Engineering Department in the State has been undertaking the construction of private tubewells both with hand and mechanically operated drilling rigs. While the State tubewell is of a standard design capable of irrigating 400 acres in a year, the private tubewells are smaller in size and have an average irrigation capability of 100 acres. The cost of constructing State and private tubewells for every acre of new irrigation area has so far averaged to Rs. 162 and 70 respectively. Time taken for completing tubewells is 2 to 3 months.

More popular use of groundwater is found on the large number of open wells. New wells in increasing numbers have been constructed in addition to improving the old ones. Improvement on well irrigation has been largely affected by boring into deeper water bearing and layer which results in larger water availability. Pumping set installations have been generally carried out on all wells that have satisfactory water availability. Both diesel-drive and electric pumpsets have been installed. Besides pumping sets, use of persian wheels has also been encouraged by offering loans. Average cost for new irrigation on all these items has been as below:—

(a) Constructing new wells—Rs. 83 per acre
(b) Improvement on existing wells—Rs. 32 per acre
(c) Installation of persian wheel—Rs. 32 per acre
(d) Installation of pumping set.—Rs. 63 per acre

The irrigation benefit from all the above works has been almost immediate. The Directorate of National Sample Survey in the Ministry of Finance had carried out in 1954-55 sample check on Minor Irrigation projects in Pepsu and have reported actual figures of achievement separately for masonry wells, pumpsets and tubewells. While the performance on wells and pumpsets has been more than fulfilled, there has been some lack in the achievement of forecast irrigation on tubewells. On the State tubewells, the water distribution channels have not been constructed everywhere with the result that the water pumped at the tubewell is normally utilised on the entire command. The tubewell construction with a discharge as high as 1½ cusecs cannot be considered complete unless its water distribution channels start reaching the pumped water supplies to all corners of the command.

No surface water storage for irrigation purposes was observed. The losses due to seepage and evaporation are so appreciable that it has not been felt advisable to store appreciable water quantities in any part of the State. An attempt made in the Mohindargarh area did not bring about the estimated surface water average.

(3) PROSPECTS.

After the irrigation benefits from the two Canals systems have fully matured consequent to the completion of the storage at Bhakra, the only two areas in Pepsu that would require attention would be the Districts of Mohindargarh in the south and Nalagarh and Kandaghat hilly area in the north. In Mohindargarh the slopes are much too adverse for any extension of irrigation from the existing Western Jamuna canals. Surface water storage may also not be desirable because of the high order of seepage and evaporation losses. Contour bunding and dry farming methods may be tried for benefit to the Kharif cultivation. As the soils are generally porous and the rainfall more concentrated in the early part of the monsoon season, benefit to Rabi cultivation may be doubtful. Finally reliance could be placed on groundwater. It would, therefore, be desirable to take advantage of groundwater storage by trying construction of sub-surface dams at places where impermeable layers can be located at a shallow depth. Groundwater abstraction from deeper depths would depend upon the results of the exploratory drillings under the Groundwater Exploration Project. If unfortunately, the aquifers are scarce, open well constructions may have to be intensified and could perhaps be depended upon if proper groundwater recharge conditions are arranged by the construction of sub-surface dams.

For the hilly areas in Nallagarh and Kandaghat, diversion canals, locally called "kuhls" appear the only solution. Generally, it should be possible to arrange gravity flow, but at some places the water in the stream may be rather lowly placed and may require water lifting. The economics of such lift irrigation would finally depend upon the order of lift and the availability of cheap electricity. Such cases could be considered after the network of hydro-electric power generated at Bhakra is completed.

Besides attending to the Mohindargarh and the hilly areas of Nallagarh at Kandaghat, it may also be desirable to examine the irrigation requirements of a large number of pockets of newly reclaimed areas that are gradually being brought under cultivation all over the State. Most of the blocks would be irrigated by the gravity flow. At a few places, it may be necessary to take advantage of the available groundwater.

(4) SUGGESTIONS

(a) *Technical*

As the State is served by the two Canal systems, construction of any minor irrigation scheme should be preceded by a proper scrutiny, so that there is no overlapping of benefits. All cases of well or tubewell constructions in the existing command area of canals should be got examined by the Irrigation authorities before such constructions are financed.

In the assessment of irrigation benefits from different types of Minor Irrigation schemes, care should be taken to separately find out the benefit from the individual item. It was observed that sometimes the benefited area on account of a pumpset installation does not indicate its individual contribution as distinct from the irrigation capability of the well itself. Similarly an improvement like a boring done to a well should have its irrigation benefit separately assessed.

In the construction of private tubewells that are got drilled by agencies other than the Agricultural Engineering Department, it would be important to make available to the parties full advice on the type of screen and the method of development that would make available to the parties optimum quantities of groundwater. On several such constructions, inferior type of filters were being adopted.

Improved water lifting appliances may be attempted by trying the new type of persian wheel which does away with the long length of shaft and saves even the use of one bearing.

Financing of diesel-driven pumping sets may be discouraged, as hydro-electric power from Bhakra should be available before such diesel engines have worked their anticipated life.

(b) ORGANISATION

Construction of small channels by popular contribution may be organised to start with in the commands of tubewells.

No subsidy for well construction need be given, as information about the sub-surface conditions is known with a good deal of certainty.

In view of the increasing activity of the State tubewell irrigation, it may be desirable to combine the Boring Organisation of the Agricultural Engineering Section with that of the Irrigation Department.

Construction of kuhls has yet to be organised. These constructions should require careful survey. It would, therefore, be desirable to entrust the surveys and construction of all kuhls to the Engineering Set-up in the State. After construction, such kuhls that do not irrigate more than 200 acres, could be maintained by the beneficiaries under the general guidance of the Revenue Administration. The Revenue Administration could be staffed with Assistant Engineers and Overseers who would be responsible for assuring that the beneficiaries maintain the completed kuhls as per standards previously laid. Enhanced land revenue on the entire area that is brought in the command of such kuhls would work as an incentive for proper maintenance by the beneficiaries.

REPORT OF THE MINOR IRRIGATION COMMITTEE ON SAURASHTRA

(1) Outstanding Features

The State of Saurashtra is a peninsula with the Rann of Kutch in the north, the Arabian Sea to its west and the Gulf of Cambay to the south. A central range of highlands running from east to west is responsible for a large number of rivers that radially flow out to all portions of the peninsula. Towards the south, there are higher ranges of hills called 'Girnar' in Junagadh and Barda hills near Porbander. At one place known as Gorakhnath in Junagadh, these hills reach a height of 3,664 feet. Because of these higher ranges in the south, a large precipitation of moisture is assured, while the northerly area has a relatively less rainfall from the south-west monsoons that sweep over the peninsula. Annual precipitation in the southern portion of Sorath District is around 35", while rainfall in other Districts of Hallar, Madhya Saurashtra, Zalawad and Gohilwad ranges between 18" & 25". Maximum precipitation is consistently observed in the month of July. Appreciable rains averaging to over 2½", continue in September and quite frequently there are showers even in October. Thereafter the weather is dry. Rainfall deficiencies have, however, been felt once in 3 to 5 years. Generally maximum shortage is experienced in the month of September. Because of this rainfall distribution, almost all the rivers are in spate in July and August but thereafter the water supply sharply declines with the result that not many streams have any water flowing therein in the hot months. The rivers flowing south from the high hills of Girnar have relatively a longer spell of water supply and some of them are known to carry sufficient water discharges even till April and May. The rivers flowing to the north have a flatter slope than those rushing to the south. Occasional floods have been observed because of the rivers over-flowing their banks particularly at places where the rivers enter into the flat area bordering the sea coast.

(ii) The soil in the central part of the peninsula varies from deep black to light shallow; a major portion of the northern parts of Halar, Madhya Saurashtra and Zalawad Districts has the predominance of light shallow soil. The coastal fringes both in the south and to the north have got some alluvium which frequently has saline water. A high percentage of the peninsula is underlaid with Deccan trap, but deep alluviums are consistently come across to the north-east in the District of Zalawad. Shallow Alluvium is also observed along the coastal fringe.

(iii) The cropping pattern is based on rain-fed conditions. Consequently, intensive cultivation is noticed during Kharif. The cropped area in Rabi is relatively small and in the hot weather there is not much agricultural activity. Among the cash crops, groundnut is accorded the top place except possibly in Zalawad where cotton is equally popular. Growing of wheat under well irrigation has been in evidence at quite a number of places.

(2) IRRIGATION PERFORMANCE

Prior to integration, Saurashtra comprised of a large number of independent Princely States who did not pay much attention to irrigation except, to some extent, in the old State of Bhavnagar, with the result that hardly 30.000 acres were under irrigation from tanks and canals at the time of integration. Individual effort at well construction had, however, contributed to as much as 3,00,000 acres. These irrigation benefits did not have any increase in the following years till the First Plan was launched in 1951. In the First Plan period, besides offering financial assistance to the continued construction of wells new minor irrigation schemes of tanks, weirs and canals were also financed. Alongside, construction of several major projects was taken up. The combined contribution from all these works increased the irrigation potential by 1 lac acres besides the well irrigation which aggregated to 3,90,000 acres, at the end of the First Five Year Plan.

(ii) In the irrigation potential on works other than wells, the major irrigation schemes contribute a high percentage of 90% and the minor works only 10%. While the figure of 3,90,000 acres is the actual irrigation on wells, the irrigation on major and minor works did not mature as much as they were meant for. As against 1 lac acre irrigation potential, only 20,000 acres of additional irrigation was actually reported. Though the irrigation on minor works was quite close to the target figure, the major irrigation fell much short of the forecast. The State has set a Water Utilization Committee to investigate into the meagre use with the newly completed works have been put to. Though the total irrigation possibility including that of well in the entire State at the end of the First. Plan is of the order of 6% of the total cultivated area. Maximum irrigation is in Sorath District where the irrigation arrangements aggregate to over 12%. The Zalawad District has the least irrigation facilities aggregating wholly 1½%. The remaining Districts of Madhya Saurashtra, Halar, and Gohilwad have 4·6 and 5% irrigation arrangements respectively.

(iii) Well irrigation is most popular in Sorath District and has been least effective in Zalawad where brackish water has been repeatedly observed.

(iv) The time taken for completing minor irrigation schemes has been generally one to two years for tanks and weirs and six months for a new well. Repairs to existing wells or their deepening and blasting have been completed between 2 to 3 months. The relative cost for completing different types of Minor Irrigation schemes per new acre of irrigation averages to Rs. 900 for new tanks; Rs. 250 per acre for new wells and Rs. 125 per acre for repairs to existing wells. Consequent to intensive undertaking of well repair, fewer wells are now reported in disuse. In one year between 1952-53 & 1953-54, the percentage of wells in disuse was reduced from 4 to 1%.

(v) The maintenance and operation of wells is the exclusive responsibility of the owners of the wells. The maintenance of other minor irrigation schemes like tanks, weirs and canals is the complete charge of the State Public Works Department. Prior to integration, minor works were looked after by the Revenue Department. Experience thereon was not reported satisfactory and the irrigation works were observed to be getting into disrepair; hence the State decided to entrust the maintenance of all such works to the P.W.D.

(vi) The Public Works Department assesses the actual irrigation done on each scheme. The irrigation rate is assessed on the basis of the crop that matures. Varying crop rates have been approved but they all average to some Rs. 12 per acre. No irrigation cess is realised, but the State has a proposal to impose betterment levy on even minor irrigation works.

(vii) No noticeable contribution either in cash.or labour was received from the benficiaries in the construction of these works. Large scale well construction is the best evidence of the use made of local resources and talent. In the matter of new well construction, the State has been arranging the required materials like cement and steel for the borihg and deepening of existing wells. The State's Boring Unit has been available to the cultivators at certain pre-fixed charges.

(viii) The maximum irrigation benefit was brought about in the year 1953-54 when 0.60 lac acres were added to the irrigation capability in the State. This tempo of constructions is reported to be in full swing in the following years and should be capable of being stepped up during the Second Plan.

(ix) Some contour bunding has also been attempted specially in the Zalawad District where 600 acres has been dealt with at an average cost of Rs. 60 per acre. Majority of earthwork in bund construction has been done by manual labour. As per provisions of the Land Improvement Act, the cultivtors have to look after the maintenance of contour bunds.

(x) The assessment of irrigation benefits on wells is made by the Revenue staff during their normal duties of recording the crops cultivated in their charge. The State, however, does not enhance the land revenue on well irrigated area till the next Land Settlement Operations.

(3) PROSPECTS

(i) As the source of all surface water in the State is rainfall which is not uniformly distributed all the year round, the utilisation of surface water would generally necessitate water storage. On some of the rivers flowing to the south, where relatively longer spells of water supply were observed, it may be possible to arrange gravity flow irrigation even for rabi crops by the mere construction of diversion weirs. Water storages will, everywhere, have to be done for the single and main purpose of irrigation. Not much hydro electric generation is anticipated nor any of the storages specially designed for controlling floods. The cost of such storages will thus have to be exclusively borne by irrigation; hence all such schemes would be costly in initial outlay.

(ii) The gravity flow irrigation relatively new to the State. People have age-old experience of only lift irrigation from wells. The development of irrigation on the few major works completed recently has been slow. Under the circumstances, it may be advisable to take up a higher percentage of minor and medium schemes that would gradually develop the irrigation area for the State without heavy investments.

(iii) The Water requirement under the prevailing popular cropping pattern is mainly for rabi and for casual short duration rainfall deficiency during kharif. For this type of requirement, it may be unnecessary at least in the initial stages, to build up large storage tanks. Such major schemes may be taken up when there are indications of more intensive all-the-year-round activity on agriculture requiring carry-over of water storage capacity from one year to another. The chances, therefore, are that in the immediate future minor and medium irrigation schemes would be taken up in larger numbers. Of course, the feasibility of each type of scheme has to be examined for the particular features of a certain tract. There are places where only minor irrigation schemes can be constructed while there are others where major and medium ones are feasible. The situation in each case would decide the issue.

(iv) Besides the storage schemes, diversion works of the type of Bhandaras popular in Bombay have a good future particularly in the Sorath District and partially even in Halar District. It may be possible to irrigate rabi on a good many of these diversion weirs. A complete reliance for all the year round irrigation can, however, be placed on ground water. Ground water is not immediately effected by the seasonal variations and is well protected from high temperature and consequent evaporation losses. Unfortunately, abundant water supplies cannot be obtained from sub-surface except possibly in Zalawad District where water under artesian pressure has been frequently observed. Top layer water in Zalawad District is brackish, but the deep seated aquifers carry sweet water. This could be tapped and delivered without getting contaminated with top brackish water. In the All-India Ground-water Exploration Project, this area has been included for investigations into possibilities of introducing large-scale tube-well irrigation.

(v) In other parts of the State, the Deccan trap is consistently observed except for a thin fringe along the coast. The disintegrated rock in between the lava flows usually has water availability that can stand to small-scale pumping. As the ground water supply is not sustained continuous running of lift irrigation is not possible. For the sort of chequered irrigation, pumping, diesel driven pump sets would continue to be popular as against any large-scale electrification of pumping sets.

(vi) Occasional pumping on streams should be possible particularly in the southern and central regions where perennial water supplies have been observed for longer part of the year. Such pumping can, with advantage, be located in the flat plains where the rivers run on relatively higher levels. Pumped water at such places can be easily conveyed to the irrigation area.

(4) RECOMMENDATIONS

(a) Technical

(i) Irrigation in Saurashtra is comparatively new. Hence, there is need for proper surveys of not only the natural resources but also a thorough investigation of the agricultural improvement that can be gradually adopted by the cultivators on irrigation water being available. The agrarian past has been primarily a pastoral economy with occasional meagre cultivation of rain fed crops. The absence of irrigation facilities in the past has been responsible for the agricultural practice of cultivating only such crops that can grow on the meagre rainfall or have deep roads to enable tiding over long spells of dry weather. A good deal of education and demonstration would, therefore, be necessary for proving to the cultivators the new cropping pattern that they need take to on the arrangement of irrigation supply.

(ii) In regard to the survey of water resources, a certain number of gauge points should be set up all over the State for accurately determining the run-off. The rivers carry appreciable quantities of silt. It is, therefore, important that observations should be made as regards the charge of silt that the run-off in different parts of the State would carry under varying rainfall conditions.

(iii) The two primary sources of irrigation *viz.*, the surface water and the ground water utilisation will have to be tackled in an organised intensive manner particularly because the irrigation achievement on surface water utilisation has been pretty meagre in the initial stage, but is increasing year by year. On the ground water utilisation, both new construction of wells and improvements on the existing ones would require an organisation that can advise the cultivators about the suitability of strata and in addition make available to them the equipment and materials that would encourage increased utilisation of ground water.

(iv) The State is frequented by cyclones which result in heavy downpour either in the beginning of the monsoon or at its end. Such cyclones require heavy order of flood-escape capacity at the storage tanks. The design of the spill-ways, therefore, deserves particular attention.

(v) The cost of water storage per acre of new irrigation in Saurashtra is working out higher than that in Kutch. Main reason for this may be because of the difference in labour rate. It is suggested that the analysis of cost being adopted in Kutch may be examined with a view to effecting economy in the earth-work rate prevalent in Saurashtra.

(vi) Ground water supply in a major portion of the State will be rather small because of the prevalence of basalt trap rock. The north-east portions in the Zalawad District have, however, got alluvium with water under pressure. Attempts so far have, however, yielded artesian supplies with a doubtful chemical content. It may be that the artesian water come across at the deeper depths gets mixed with brackish water present at shallower location. Fresh attempts should, therefore, be made for tapping the artesian water supplies in such a way that the top brackish water supplies do not contaminate it. This investigation can best be done on the exploratory work that is planned for the area under the All India Ground Water Exploration Project.

(vii) In the rest of the State, limited water supply can be had on large diameter wells if they are constructed in areas that have statisfactory recharge conditions. Almost all the aquifers would be horizontal; hence their location should not be difficult to decide. Care, however, should be taken to protect all the places of ground water recharge. This can be done by properly gully-plugging the streams.

(viii) Improvements in ground water supply can further be effected by the construction of percolation tanks and weirs. So far these have not been encouraged because they are incapable of bringing about direct irrigation benefit. Their importance is, however, significant for Saurashtra, because they can invariably be depended upon for replenishing ground-water supplies. It should be possible to carry out observations with a view to marking out the area over which the ground water is replenished by such water conservation measures.

(ix) Ground-water utilisation in coastal area needs a special study of the salt water intrusion problem. So far, no sub-surface investigations have been done. It may be desirable to carry out some drillings with a view to locating the sweet water zone and evolving the best manner of tapping these aquifers.

(b) Organisation

(i) The State has got a Superintending Engineer in charge of the irrigation works. The Executive Engineers under him carry out the survey work and are also responsible for the construction work in the area of their charge. In view of the extensive work of surveys and investigations, it may be desirable to set up separate Divisions for this important work.

(ii) There are possibilities of over 6 lakh acre irrigation facilities in the State being arranged from surface water resources. So far the State has achieved only 1,30,000 acres irrigation. There would, therefore, appear need for planning the future surveys in a systematic manner.

(iii) In regard to the ground water utilisation, the activities of the Boring Section of the State should be enlarged so as to include an Advisory Unit in addition to intensifying their present activities. The Advisory Unit should be staffed with Geologists and Hydrologists who have intimate acquaintance with the work done so far and the surface geology of the entire State. All ground water utilisation should be on the advice and recommendation of this Unit.

(iv) The maintenance of individual enterprises like wells, pumping on streams etc. is the responsibility of the owners. All other works not belonging to individuals are in the charge of the Public Works Department, who maintain capital and revenue accounts for that scheme. Area actually irrigated is assessed on the maturity of different crops. Different rates are charged for a variety of crops. The average of these rates of Rs. 12 per acre of irrigation is rather high as compared to the irrigation charge in other States. This may be retarding expeditious irrigation development in the State where the people are not irrigation minded everywhere. The State may consider the possibility of realising these charges in two parts *viz.* a compulsory assessment plus a varying rate for the particular use made of water. The compulsory charge may take care of the maintenance expenditure that has to be incurred irrespective of the irrigation area.

(v) *Popular contribution.*—No contribution in cash or labour has been noticed except a compulsory realisation that is effected through the collection of betterment levy. Because of the new start that the State has made on irrigation, it may be desirable for the State to shoulder the responsibility of both construction and maintenance of a number of large works, but a start on public reliance could be made by entrusting the maintenance of small works such as those that irrigate upto say 50 acres.

(vi) The State is reported to be taking steps to relieve the PWD from maintenance of medium size works which are capable of irrigating 750 acres. The State wants the maintenance of such works to be carried out by the District Panchayat. The District Panchayats should have regular technical staff of Deputy Engineers and Overseers, deputed from the PWD. Such organisation can look after the maintenance of irrigation works between 50 & 750 acres.

(vii) So far, the State has experienced shortage of Overseers. The requirement is of the order of 150 hands per year. The State has, however, started a training course and expects this requirement to be met within another two years. The Assistant Engineers required for staffing the District Panchayats would every time be officers deputed from the regular P. W. D. This practice of obtaining officers on deputation should be continued because direct recruitment of Assistant Engineers by the District Panchayats would not make available to the latter satisfactory hands particularly because the District Panchayats cannot hold out attractive future for such hands.

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MINOR IRRIGATION COMMITTEE REPORT ON SAURASHTRA, SUMMARY

(1) Irrigation works were practically unknown in this State prior to its integration. During First Plan, irrigation facilities have been arranged for nearly 6 per cent of the cultivated area in the State. Well irrigation has the largest contribution. Other irrigation works have so far a total irrigation area of 1 lakh acre. The District of Corath has maximum irrigation arrangement of over 12 per cent of its cultivated area.

(2) Construction of wells and its repair is completed within six months, while tank constructions usually take a year or two. Repairs programme of wells has reduced the number of wells-in-disuse from 4 to 1 per cent.

(3) Maintenance of minor irrigation tanks and weirs of all sizes is the responsibility of the State Public Works, Department.

(4) Varying irrigation rates are charged for different crops that mature. No irrigation cess is realised.

(5) Maximum use of local resources and talent has been on the large-scale well construction.

(6) The tempo of construction was best in 1953-54 when irrigation facilities for 64,000 acres were arranged in a year.

(7) Contour bunding has so far been attempted only on 6,000 acres in the Zalawad District.

(8) All storages of surface water are primarily designed for irrigation. No other purpose of hydro-electric generation or flood control has been projected.

(9) Rain-fed crops are primarily grown in the State; hence the development of irrigation is rather slow. It may be advisable to take up, in the initial stages, only minor and medium schemes.

(10) Construction of diversion works like the bhandaras of Bombay should be encouraged particularly in Sorath and Hallar District.

(11) There are good prospects of irrigation from groundwater in the Zalawad District. So far, not much progress has been made because of the brackish water that persists in the top layers. Deeper depths need be drilled for satisfactory quality water.

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(12) Water lifting on open wells in the rest of the State may be continued with diesel-driven sets particularly because sustained plentiful groundwater supply is not available everywhere.

(13) Water lifting from streams should be possible on the southern and central regions where water flow is observed even in non-monsoon months of the year.

(14) For fuller use of irrigation facilities, a good deal of education and demonstration appear necessary to reorient the agricultural practices in the State that have so far been based on rains.

(15) For ascertaining the available water resources in the State, it is important to set up gauge points all over. These observation points should also record the quantity of silt charge.

(16) As groundwater conditions are not favourable everywhere, it will be necessary to set up an organisation that can make available to the cultivators information about the sub-surface starta.

(17) Design of surplusing arrangement on all storage tanks should provide for heavy floods that cyclones bring about.

(18) The cost of earthwork in the State is higher than that in Kutch. Cost analysis of earthwork rate need be examined.

(19) Artesian water supplies in the Zalawad District need be tapped by excluding the brackish water that persists at shallower depths. Investigations under the all-India Groundwater Exploration Project need finalise design for larger-scale utilisation of the artesian supplies.

(20) For sustained groundwater supplies on open wells, it would be necessary to protect places of groundwater recharge by gully-plugging the local streams.

(21) Construction of percolation tanks and weirs may be undertaken after determining the extent of groundwater replennishment that these bring about.

(22) Sweet water zones in the coastal alluviums need be located.

(23) Present arrangement of getting surveys and investigations done by the P.W.D. Divisions responsible for construction may be replaced by separate survey staff. There are good prospects of 6 lakh acre irrigation from surface water sources alone. So far, only 1,30,000 acres irrigation arrangement has been made; hence surveys need be organised in a systematic manner.

(24) Rather high irrigation rates are at present being charged. The State may examine the possibility of a two-part tarrif made up of a compulsory assessment to cover the maintenance expense plus a varying rate

for the specific use made of irrigation water. While the compulsory charge would take care of the maintenance expenditure, irrigation development may have a better chance.

(25) Maintenance of smaller works can be entrusted to the beneficiaries by handing over the works to the Panchayats. The Panchayats must, however, employ technical staff. While subordinates could be recruited directly from outside, the services of Engineers need be obtained from the Public Works Department. Direct recruitment of Engineers is not likely to attract good hands, as the Panchayats would not offer them prospects that the P.W.D. can.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON HIMACHAL PRADESH

I. Outstanding Features

1. Formed by integration of hilly States, Himachal Pradesh has exclusively mountainous topography. The whole State is beset with valleys and mountains of the Himalayan series ascending from the Siwalik Hills to the great Central chain of the Western Himalaya. The elevation varies between 1,000 to 16,000 above mean sea level generally with a few peaks rising to R.L. 20,000 and above.

2. The principal rivers which affect the drainage of the State are the Chenab, the Ravi, the Beas, the Sutlej, the Tons and the Giri (the latter two are tributaries of River Yamuna). All these rivers are snow-fed and have a perennial flow.

3. The rainfall in the State generally varies from 25 in. to 80 in. except in some parts, such as Chini and Pangi Tehsils where it is less than 25 in. It is generally more on the windward side of the ranges than on the leeward side. Though a major percentage of the precipitation is received during the monsoon months, *i.e.*, June to September, about 25% of the total precipitation is fairly even distributed among the remaining months.

4. Much the larger extent of the soil is of the wet forest type under growth of perennial forests. Fertile and cultivable soil is generally found in the State in the alluvial valleys of the Siwalik zones or the north facing gentle slopes of the ranges. The south faces of the mountains are generally too precipitious and exposed to the denuding agency to have an extensive and deep soil cover.

5. In spite of the mountainous topography which defies cultivation, agricultural activity is noticed in the State all the year round. On the lower hills, rice is predominant crop for the kharif season while maize is also exclusively cultivated on high as well as low altitudes. Wheat and Barley are exclusively grown in the winter season. Out of a total annually cultivated area of about 6·5 lac acres, about 3·5 lac acres is annually under double cropping. The prospects for a successful kharif as well as rabi harvest chiefly depend upon the favourable distribution of rainfall in the winter season.

(2) IRRIGATION PERFORMANCE

1. The total geographical area of Himachal Pradesh is 69.74 lac acres out of which approximately 6.5 lac acres are annually cultivated. Prior to launching of irrigation development programme in the State under the First Five Year Plan, the total area that received seasonal or perennial irrigation was of the order of about 95,000 acres. Most of this irrigation benefit was provided by small private irrigation gravity channels which were constructed, years back, and maintained by the cultivators themselves. These channels, locally called kuhls, did not have, in the modern sense, any proper headworks, regulation arrangements or cross drainage works and resulted in great waste of water. In spite of these drawbacks, their projection in the difficult hilly terrain is an ample evidence of private contribution and agricultural keenness on the part of the hill farmers of the old order.

2. The irrigation programme in the First Five Year Plan provided, according to the initial estimate, for extension of irrigation facilities to an additional area of 40,000 acres through construction of new kuhls and for improved and more assured irrigation supplies to existing 60,000 acres by effecting improvement in the existing kuhls. Against this planned objective, the State, however, could complete only 87 schemes, details of which are given below:—

District	No. of Schemes	Total Cost	Irri. potential
Mahasu . .	8	112,575	1286 acres
Sirmur . .	31	159,074	2518 acres
Mandi . .	14	349,052	3489 acres
Chamba . .	34	1,081,746	5782 acres
TOTAL .	87	1,702,447	13075 acres

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3. Besides completion of the above schemes, the State also incurred an expenditure of about 15 lacs on 68 additional schemes which could not be completed in the First Five Year Plan period and would, therefore, be continued in the Second Five Year Plan. These schemes will yet require another sum of Rs. 35 lacs for completion. Their irrigation potential on completion would be of the order of 22,500 acres.

4. In addition to the above progress under G.M.F. funds, the State also incurred an expenditure of about Rs. 2,50,000 on small irrigation schemes implemented under the Community Project Organisation and completed some of the Schemes having an irrigation potential of 2,225 acres.

5. The chief reasons for the slack progress of irrigation development during the First Five Year Plan are two-fold. Firstly, the State Government had to set up its irrigation organisation from a scratch. This was not an easy task in the face of acute shortage of technical officers. The State tried to recruit technical officers on deputation from other provinces, but till today, the State irrigation organisation does not have an adequate strength of technical hands. Secondly, the work of investigation and surveys, as also of construction of irrigation works in the interior of the difficult mountainous region with scanty communication, presents numerous working difficulties which can only be surmounted through experience gained in the course of time.

6. The cost per acre for completed schemes during the First Five Year Plan works out to a little over Rs. 11. As these schemes were mostly improvement schemes for the existing kuhls, the cost has been on the lower side. The cost per acre for the other 87 continuation schemes which comprise only schemes for new kuhls is of the order of Rs. 225 per acre. The State tried to collect voluntary contribution from the beneficiaries to meet part cost of the works, but did not meet with much success.

7. Time for completion of Minor Irrigation Kuhls would actually depend on the cost of the schemes which is proportionate to the magnitude of the works involved. Generally speaking, a kuhl costing less than 2 to 3 lacs may take a year for completion while a kuhl costing more than 2 to 3 lacs may require 2 working season for completion.

8. While the development of irrigation benefits on the improvement schemes is almost immediate, it appears likely, on the new completed schemes, that it may take four to five years to attain full irrigation benefits. According to the present proposals, the State P.W.D. will be responsible for maintenance of all the new irrigation schemes as also all the old schemes witch are improved upon by the State. No definite policy has yet been framed regarding maintenance of new or improvement schemes implemented under the Irrigation Programme of the Community Project Organisation of the State. The cost of maintenance of kuhls per-acre of irrigated area, is more for the first few years of construction after which it is likely to reduce. It will still be higher as compared to maintenance cost in the plains, due to two-fold reasons. Firstly, the cost of transport of cement is high and secondly, the extent of annual damage or disrepair is more on account of land-slides and erosion, etc. All the kuhls that are maintained by the P.W.D. will be in the complete ownership of the State; hence all irrigation thereon will be liable to water tax for any crop that is irrigated.

9. The State has recently passed an enactment under the title "The Himachal Pradesh Minor Canal Act, 1955" which empowers the Government to levy such water rates for the use of water from the canals. These

rates shall be determined keeping due regard of the maintenance and operation charges for the system and the cost of collection of water charges. The Act also makes necessary provision by virtue of which, the State can assume control partially or wholly over any privately maintained canal in case there is either neglect of maintenance or dispute of some other nature. It is proposed to bring the enactment into force since the rabi crops of 1956-57; the water rates to be charged, have not yet been specified. Besides the irrigation rates, the above Act also entitles the State Government to levy betterment charges on the area benefited by any canal newly constructed, remodelled, extended or repaired wholly or partially at Government cost.

(3) PROSPECTS

1. The topography in the State is much too rugged; hence possibility of getting a large compact flat area for irrigation is remote. Benefit to the small cultivation patches from Minor Irrigation works costing less than Rs. 10 lacs will have to be mostly confined to diversion schemes. Storages would be costly on account of steep slopes in the steams and may not be justified for the small irrigation benefit that is popularly needed in the State.

2. The State would have to depend wholly on the Minor Irrigation Schemes for its irrigation development. Even though sufficient water may be available in the streams, major or medium schemes, will not be feasible due to limitation of land resources.

3. Prospects for groundwater utilisation are very slender. In the alluvial valleys, a few tubewells may be successfully drilled, but there does not appear much chance for a wide-scale groundwater pumping.

4. Though it should be generally possible, to extend gravity irrigation to most of the tracts, yet occasionally, the water in the streams may be rather lowly placed as compared to the cultivated land and may require lifting. The economics of such lift irrigation would actually depend upon the order of the lift and the availability of cheap electricity. Such cases should generally be considered after the hydro-electric development in the State has reached an advanced stage and cheap electric power for pumping is available.

5. The irrigation demand is likely to be more outstanding on the leeward tracts of the various rivers that sweep across the State. The Yamuna, the Beas and the Ravi valleys are more or less opened up already by construction of roads and the Satluj valley is being opened up by the construction of Tibet road. The prospects are that more of the irrigation proposals in near future will be concentrated in those valleys, while the irrigation development in the Chanat valley will follow as it is also opened up in the course of time.

6. The irrigation requirements on schemes that are completed at high altitudes of the order of 7,000 and above, would be pretty diversified between maize, barley and horticulture. At lower heights up-to 5,000 feet and below, paddy and wheat may be the predominant crops. The slopes are too steep for any tea cultivation.

7. Allowing for the requirement of snow-covered areas and considering the fact that it will not be wise (due to fear of increasing the soil erosion) to deforest the areas and reclaim them for cultivation, it is not likely that the State would exceed an ultimate potential of 10 lac acres of cultivated area. As this cultivated area will be scattered, the intensity of irrigation materialised will not be high. Taking it to be 30% of the cultivated area, the total requirement of irrigation for the State may be forecast as 3 lac acres. As against this figure, the State is likely to attain an irrigation potential of 1.75 lac acres by 1961, as a result of the schemes to be executed under the Second Five Year Plan which has a total irrigation target of 60,000 acres for the State.

(4) RECOMMENDATIONS

(a) *Technical*

In the absence of properly organised surveys and investigations due to shortage of technical heads, the State has been undertaking construction of new kuhls on an *ad-hoc* basis. It would be advisable for the State to study the potentialities of the streams as a whole and prepare a master plan for the utilisation of all the water available in the stream before taking up new individual schemes. The over-all study should be directed for finalising minimum number of schemes. The over-all study should be directed of tackling the irrigation on a stream in bits.

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2. In view of difficult communications and shortage of technical hands, it is important that the State should not scatter construction work at a larger number of places at a time. If the State undertakes a few schemes at a time, completes them and undertakes the next set of few schemes thereafter, instead of tackling a large number of schemes simultaneously, it will not only ensure better supervision of works with scanty strength of technical staff but also result in more expeditious execution.

3. Provision of masonry lining of kuhls should be carefully considered for each individual schemes. It increases the initial cost but in some reaches it may be indispensable and result in over-all economy in course of time, while in others, it may be superfluous. It is indispensable in reaches where expensive rock blasting is resorted to. It would be very much desirable in porous reaches for the safety of the banks besides effecting saving in seepage losses. In reaches of expensive cultivated land, the need to reduce the width of land to be acquired may make it imperative to line the portion of the kuhl.

4. For efficient working of the kuhls in the hills, it is important that the crossing of the kuhls with hilly streams as also their alignment and section in the hilly stretches subjects to slips and land-slides should be carefully designed. Syphoning of kuhls for negotiating the crossing of the streams, should be avoided as far as possible because the syphon is likely to be checked with shoal in course of time and lead to lot of trouble. The better alternative in all such cases, would be to provide a covered masonry section so that the stream or the land slip passes over the kuhl without affecting its flow. Feasibility of carrying water in pipes in such reaches, could also be considered in case of small kuhls.

5. Irrigation channels in the hilly tracts, act as storm water drains also. It is therefore, important that escapes are provided at suitable interva

6. For areas where paddy is likely to be predominant irrigated crop, the irrigation channels should be designed as monsoon rice-channels in order to take full benefit of the water available in the stream, instead of restricting the full supply discharge to that available in the present stream during hot weather.

7. It is essential that along with irrigation schemes active measures are taken for afforestation and soil conservation in the particular tracts that are included in irrigation command as well as in such reaches where irrigation channels across the stretches, subject to heavy land-slides.

8. The rolling topography of the tracts will be eminently suitable for introduction of spray irrigation, for, orchard and vegetable, etc. In tracts where enough water head is available, it will be worth-while exploring the possibilities of making direct use of the hydraulic head for working the spray-nozzles and thus do away altogether with the costly item of pumping.

(b) *Organisation*

1. Planned and systematic construction of irrigation works in the State requires careful preliminary investigations and surveys. Though the State has now two irrigation divisions with head-quarters at Simla and Mandi, they are not, as yet adequately staffed for undertaking surveys as well as construction work properly. Both these works in the State being of different and specialised nature, it is also essential that the State should have atleast some proportion of the staff which has sufficient irrigation experience. The State should, therefore, make special efforts to strengthen its irrigation organisation and, if necessary, offer some special allowances in lieu of harder life in the hills.

2. While it may be desirable to entrust the construction of some irrigation works to the engineering set-up in the State, because of skilled nature of works involved, such as the blasting of rocks, alignment of

kuhls and masonry lining, etc., it is also necessary to associate private contribution and enterprise as much as possible with these works. With this object in view, the State should encourage construction of smaller and simpler works by the people themselves through the agency of C.P.A. Efforts should also be made to harness voluntary labour and contribution for all the works that are executed specially those under the Community Project and Nation Extension Blocks.

3. In accordance with the policy adopted in regard to the construction of kuhls, increasing reliance should be placed on the local beneficiaries for proper maintenance of kuhls that do not require skilled attention of the State P.W.D. People's contribution may not be available for State-owned kuhls, but for the construction, extension and repairs of private kuhls, it is felt that adequate people's participation would be forthcoming.

4. The State P.W.D. is being made responsible for recording irrigation area and preparing the demand statements for the occupier's rate as well as the betterment charges which will be levied after the irrigation Act, already passed, is brought into force. The irrigation divisions, however, have, as yet, no revenue organisation comprising Ziladar, Amin and Patrols, etc., for carrying out this work. To start with, the State should provide one Ziladar with necessary strength of Amins and Patrols in each division as soon as the Act is brought into force. This organisation may further be strengthened, later on, as irrigated area increases.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON DELHI

(1) OUTSTANDING FEATURES

Delhi is a small State comprising a total geographical area of 580 sq. miles. The climate of the State is semi-arid. It receives seasonal rains from north-east monsoon during June to September; 85% of annual precipitation falls during this period. The average rainfall is 21.65 inches.

From the point of view of irrigation requirements, the State could be divided into four different zones namely the Alipur, the Najafgarh, the Mehrauli and the Shahdara.

The Alipur Zone comprises an extensive flat plain extended between river Yamuna on the eastern side and Delhi Rohtak Road on the southern side. The soil in the region is sandy loam and the area is provided with extensive irrigation facilities from the distribution system of western Yamuna Canal tail. The wells in the area occasionally tap saline water; salinity in some wells has been observed to occur as a result of over pumping.

The Najafgarh block occupies the low-lying area on the western side of the Delhi Ridge. The tract is not adequately drained. The soil in the tract, generally consists of loam with occasional silt and kanker beds. Most of the wells in the area tap saline or brackish water.

Mehrauli region forms a rocky table land, abounding in small hills and ridges including the historic Delhi Ridge which are off-shoots of Aravalli Hills. The hills consist mainly of quartzites and sand stones; in between the quartzite exposures are alluvial basins, with alluvium of recent origin wholly derived from weathering of quartzites.

Shahdara Zone comprises mostly the Yamuna Khadar land with thickness of sandy alluvium increasing towards River Yamuna. Saline water is also often met with in this area.

In Alipur, Shahdara and Najafgarh Blocks, the spring level varies from 15 feet to 30 feet below ground level. In Mehrauli Block, the spring level varies from 50 to 100 feet below ground level.

(2) IRRIGATION PERFORMANCE

The Chief sources of irrigation in Delhi State have been the Open wells and tail system of the Western Yamuna Canal. The Irrigation from the latter source has so far almost entirely been restricted to Alipur area. Out of a total average irrigation of 66,500 acres during the pre-plan period, 35,000 acres was contributed by Government canals and 28,000 acres by open wells. On completion of works, in the First Five Year Plan, the total irrigation potential of Delhi State may be reckoned as 1 lakh acres of which 45,000 acres may be attributed to Government canals, 50,000 acres to wells and rest to other sources. Following schemes were undertaken in the State during the First Five Year Plan:—

1. Sinking of new wells.
2. Repairs to old wells.
3. Installation of Persian Wheels.
4. Construction of small irrigation tube-wells.
5. Extension of Irrigation channels.

The total expenditure of about 25 lakhs was incurred during the Plan period, a major percentage of which was under the item 'Sinking of new Wells'. The total number of wells reported to have been sunk during the First Five Year Plan period is 1,435. The first four schemes in the above list had been carried out as a result of private enterprise individually or on cooperative basis and encouraged through sanction of subsidized taccavi loans. The extensions of irrigation channels of the Western Yamuna Canal system namely of Nehri major distributary in Alipur Block and Surakpur Minor and Dhasa Minor in Najafgarh Block, had been carried out by Punjab Irrigation Department. These extensions increased irrigation potential by about 10,000 acres bringing an additional culturable commanded area to 23,000 acres under non-perennial irrigation.

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Responsibility for maintenance of private wells and tubewells rests with the individual cultivators who derive benefit therefrom. No betterment levy or irrigation cess of any type is charged for these works except that land revenue is liable to be enhanced according to the wet assessment during the next settlement.

(3) PROSPECTS

The prospects of further development of surface water irrigation in the State are limited mostly to further possible extensions from the Western Yamuna Canal system. In the area of Mehrauli block, some Water Storage Schemes may also be feasible but scope is very limited due to small catchments and scanty rain-fall.

The proposal for further extension of irrigation from Western Yamuna Canal during the Second Five Year Plan envisages extension of Mughalpur Minor for benefitting an additional culturable commanded area of 62,535 acres in Najafgarh Block. The scheme is desirable from a long term view but it is not expected to give quick benefit of perennial irrigation unless the discharge in the Western Yamuna Canal itself is supplemented

Even in area where perennial canal irrigation is. or becomes available, the intensity of irrigation is not likely to exceed 40% of the total culturable commanded area. For further supplemental or quicker development of irrigation facilities in canal irrigated areas, the State will have to depend on ground water use. The irrigation development in other areas of Mehrauli and Shahdara Blocks where extension of gravity flow irrigation is not possible, will have to depend, exclusively, on ground water utilisation.

Ground water investigations, hitherto carried out, give two fold indications. Firstly, that the ground water availability is restricted due to limited recharged areas and tube-wells of normal size yielding discharge of 1½ cusces or so are not possible. Only tube-wells or small capacity of near about 12 thousand gallons per hour, can be installed. Secondly, that the salinity of water is a widely prevalent problem in the State and is liable to restrict considerably the ground water use for irrigation purposes.

The Seismic and Electrical investigations carried out, have delineated two alluvial basins in Mehrauli Block and three fresh water zones in Najafgarh Block where some 20 tube-wells installations, in all, may be possible. Even after these investigations, it is doubtful whether sufficient quantity of water could be extracted from these zones, particularly for irrigation use.

There are some possibilities of tube-well installations in the Alipur Block, to the East of Grand Trunk Road where the area comprises sandy alluvium. A few stray tube-well installations may also be possible in Shahdara Block depending upon the availability of fresh water.

Sinking of open wells and fresh water zones could be safely depended upon by the State for providing perennial irrigation to small commands. Due to small holdings, restricted water availability and occurance of salinity due to over-pumping in some areas, installation of persian wheels as water lifting device will have better prospects than installation of power pumps.

Possibility for increasing discharge at economical cost by means of boring in soft strata exists. Deepening of wells by blassting the bed rocks in rocky areas will, however, not be generally feasible because the bed rocks are abundantly fissured up to certain depth.

The rolling topography around the hills and ridges in Mehrauli area presents a scope for adoption of soil and moisture conservation measure by way of maintenance of old bunds and construction of new bunds.

Sites near Ayanagar and Dera are of special interest for implementing such schemes. As mentioned before, not many such schemes could be expected to carry out direct irrigation.

Irrigation benefit can also be extended to a limited extent of 5,000—10,000 acres by proper treatment and use of effluent from Delhi Sewage system. The Delhi Sewage scheme at Okhla is already making use of this effluent for the irrigation of 5,000 acres of vegetable cultivation on both sides on the Agra Canal. There is a further possibility of extending similar benefit on the new sewage pumping units which are proposed to be installed on Najafgarh drain and are expected to tap a discharge of about 59 cusces in the drain.

There appears good possibility of reclaiming land that is at present sub-merged under the flood waters of Najafgarh Lake. By suitably re-grading the bed of the Najafgarh Drain and, if necessary, arranging drainage water lifting, it should be possible to satisfactorily dispose off the flood water and thereby make available some 2,500 acres for cultivation of winter crops. Irrigation to any hot weather cultivation will have to be by pumping the lake water.

(4) RECOMMENDATIONS

(a) *Technical*

As the perennial benefit of irrigation from western Yamuna Canal in extended areas is yet likely to be deferred considerably, it will be desirable to make progressive use of ground water resources in the canal irrigated areas with the dual purpose of providing immediate irrigation benefit and of supplementing the canal supplies when the latter are perennially available. Extension of ground water use through sinking of open wells should be continued in all areas of the State in proper coordination with other irrigation schemes and with due regard to re-charge condition and quality of sub-soil water. It may be desirable to sink wells of comparatively larger size so that percolation is sufficient to ensure economic functioning of improved water lifting devices, like Persian Wheels, etc. For sustained use of ground water, it will be important to ensure that the completed wells are not allowed to get into disuse in the course of time.

The ground water use through State tube-wells, however, should be encouraged only after (a) satisfactory electrification plans are known and (b) adequate staffing arrangement is set up for the proper running of completed tube-well as a State enterprise and (c) fresh water bearing acquifers have been carefully delineated as a result of properly coordinated geo-physical investigations.

Boring in wells in soft strata should be encouraged for increasing the well discharge.

Pumping set installations should be restricted to only those masonry wells which have augmented supplies through boring and in areas where electric power is available within reasonable distance.

In order to make people self-reliant, it is considered desirable that subsidy granted for construction of wells should be gradually reduced.

It may be desirable to link up all proposals for extension of Sewage Disposal Work in Delhi State with installation of plants for proper treatment of sewage effluent so that latter can be profitably utilised for irrigation. This may particularly be kept in view while planning water supply schemes for Shahdara town.

Because of the excessive pressure on land in Delhi State, it will be desirable that irrigation development programme of the State is properly linked up with a master plan of the State taking into account future implication of progressive building construction and industrial development programmes.

(b) *Organisational*

As earlier mentioned, salinity of water is a widely prevalent problem in the State. In some places, salinity has been observed to have occurred as a result of over pumping. Ground water availability and lift involved also varies widely from place to place. There is, therefore, need for controlled utilisation of ground water. It is advisable that the State should have an effective organisation which will carry out necessary planning and coordination and ensure controlled distribution of wells and lifting appliances according to the particular requirements of different tracts and thus regulate extraction of water therefrom. This Organisation could also make equipment and other facilities available to cultivators regarding boring of wells, etc.

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As far as the operation and maintenance of tube-wells is concerned, it will be advisable to entrust this work to the Tube-wells Division in Punjab that is responsible for the maintenance of tube-wells in the Sonepat area of that State, instead of setting up a new organisation in this State.

REPORT OF THE MINOR IRRIGATION COMMITTEE ON ORISSA

(1) OUTSTANDING FEATURES

The State has fairly good rainfall ranging between 50 to 60 inches. The distribution year round is, however, very varying. In some districts as much as 90% of the annual rainfall is recorded during the monsoon, while other portions have only 60 to 70%. The demand for irrigation is generally more in areas where a high percentage of the annual rainfall is observed during monsoon.

Topographically, the State can be divided into three broad regions, (i) Mahanadi Delta, (ii) the Eastern Region consisting of Ganjam District and the ex-Madras State territory, and (iii) the Plateau area of the west and north-west. In the Mahanadi Delta and the neighbouring coastal area including the lower portions of the Brahmni and Mahanadi valleys, paddy is a 5-6 months crop and is generally sown in June and harvested in early December. No second crop of paddy is grown. Crops in this tract some-time suffer due to floods.

In the Ganjam and other southern districts, rainfall decreases and the soil is also light and porous. Paddy is grown both under irrigated and unirrigated conditions. Irrigated crops, however, give better yield and the benefit from irrigation is readily recognised.

In the uplands which constitute the western and north-west regions of the State, the rainfall is relatively small. Paddy is harvested in November or sometimes even earlier. The soil is non-porous and the slopes pretty fast. In this region, scarcity of water is frequently felt during September and sometimes even in October. Irrigation is in great demand in this area. The ground water does not hold out much promise for irrigation, but the undulating topography is well-suited for surface water utilisation. While not many major storages can be arranged, there are numerous sites for small schemes that can irrigate local cultivated areas.

Against a total area under cultivation of 1,40,000 acres in the State, about 1,00,000 acres are normally under paddy. 20,000 acres of the cultivated area is under irrigation mostly for the paddy crop. The acres irrigated from different sources are:—

	[in acres]
Government canals	4,71,000
Tanks	6,86,000
Private canals	76,000
Wells	70,000
Other Sources	6,32,000
TOTAL	19,35,000

Administratively, the State is made up of districts transferred from Bengal and former Central Provinces and Madras and has, in addition, large number of Princely States that were merged after independence. The individual procedure of revenue administration prevalent in the three old States is being worked. Two different Acts of Bengal and Madras are even now in operation on the irrigation canals of Mahanadi and those in Ganjam area respectively.

(2) IRRIGATION PERFORMANCE

Across the numerous streams, there has been a popular practice of throwing kutcha earthen dams. In quite a few cases, pucca masonry works have been completed, but they are not as popular as the kutcha constructions. Most of the kutcha dams are across small streams, but occasionally they have been attempted even on big rivers. Thus in the Angul Block of the Dhankanal District, there is a Bauli River scheme. It consists of a temporary earthen dam thrown across the Bauli River. A channel taken off from the upstream of this dam used to divert the river water for irrigation purposes. As no control existed, the channel got badly eroded and a portion of the river started flowing through this channel. Subsequently, another earthen dam was thrown across the second channel which had in fact become a branch of the river. For want of suitable control, this second channel has also met with the same fate. Simultaneously, the earthen dam across the main river and its branch got breached from time to time when the river was in floods. This is not a well-designed system and cannot function properly unless its design is better planned.

Irrigation water diverted at such anicuts is used by the people without paying any kind of tax to the Government. There is also no record of the land that has actually been irrigated.

Reservoir irrigation.—Popularity of tank irrigation is indicated by the fact that over 35% of the total irrigation is from tanks. Occasionally these tanks supplement the supplies that are tapped at diversion weirs.

The minor tanks fall under two categories. In one case, they are owned by the State and the Revenue Department is responsible for their proper upkeep and maintenance. On occasions when major repairs are needed, special estimates are prepared and funds sanctioned. For minor repairs, usually lump sums are given to the Panchayats. Each District has generally a provision in their annual budget which is operated upon for this purpose.

The second class of tanks are owned by Guatias or by individuals. The cutivators of the irrigable land have been paying to the guatia enhanced land revenue. Land reforms have not yet been fully introduced with the result that although the land belongs to the landholders and they pay enhanced land taxes to Government, the tanks continue to be the property of guatias. Since the guatias do not have any direct irrigation interest in the tanks, they seldom keep the tanks in proper repair.

Besides the tanks of the Revenue Department, several storage reservoir projects were undertaken with the funds of the Community Projects Programme. Many of them are nearing completion. On these constructions, the Headworks are being completed through the agency of the State Irrigation Department. The canal systems are, however, constructed by the Community Projects Organisation with people's participation in several cases.

The average tank duty adopted on the design of these works is around 40 acres per million cubic feet of storage. This is based on the consideration that the tank should be able to give two waterings of 3 in. depth each during spells of complete cessation of rains. In the bordering State of Madhya Pradesh, a tank duty ranging between 15 to 25 acre per million cubic feet has been found workable. The rainfall in Orissa being heavier, a higher tank duty appears likely though it will be desirable to carry out field observations in confirmation of this assumption. On account of the higher figure of annual precipitation, the tanks generally fill up and there is, therefore, no need for diverting neighbouring catchments. Desilting of existing tanks has not been tried on any appreciable scale nor is there enough data to indicate the loss of storage consequent to silting. On the few cases tackled, the earthen banks have been raised with the desilted stuff and care taken that after repairs the tanks do not submerge additional land.

The waste weirs of all tanks—major or minor—are designed for the high flood discharge calculated from Dickens' Formula and are based on Garrets' Tables. The design for surplusing arrangement on minor tanks follows the procedure adopted for major tanks.

Wells and Tube-wells.—Wells are most popular in the delta of Mahanadi. Primarily, well irrigation is needed for growing vegetables and cash crops like sugarcane. Quite a variety of indigenous tools are used for lifting water from different depths. Locally, they are known as janta, saina and tenda. The tenda system of water lifting is also adopted for raising water from streams. The quantity of water that can be lifted by tendas is only about 500 gallons an hour. For greater benefit to larger area, the State has purchased a number of pumpsets. These are operated by the Government and irrigation charges realised from the irrigators at Rs. 5 per acre. Rs. 3/8/- is to cover the interest and depreciation. The State has also some large-size 6 in. x 6 in. pumps directly coupled to diesel engines. These have been run for irrigating paddy during dry spells in monsoon.

About 500 tubewells of 1¼ in. and 3 in. dia. have been installed by the Agriculture Department for private parties. These tubewells have a low irrigation capability and are primarily meant for kitchen gardens. In addition, six large-size irrigation tubewells have been installed in the coastal districts of Balasor and Cuttack. These tubewells have a discharge between 30,000—40,000 gallons per hour. Depth of boring is about 150 feet. A 8 in. dia. slotted pipe is gravel-packed 2 in. all round. 60 feet of slotted pipe thus gravel packed is able to produce 30,000 gallons per hour. This indicates good groundwater availability. The tubewells are at present being run with 6 in. x 6 in. diesel-driven pumpsets and each tubewell is able to look after 200 acres.

(3) PROSPECTS

(i) *Diversion works*

During the months of September and October, several streams are known to carry flowing water. Some of the streams have satisfactory discharges even till December. It should be possible to arrange diversion of the available stream water for meeting the irrigation demand to paddy. As the streams are, however, rain-fed, their discharge may dwindle down in later months so much as to render diversion works ineffective for the irrigation of rabi crops. If storage reservoirs are, however, constructed upstream, it should be possible to irrigate rabi crop.

Quite often, the streams have rocky beds which provide cheap foundation for the construction of diversion weirs. Before, however, deciding upon any construction, it would be most desirable to collect assuring data about the minimum water flow in the streams.

(ii) *Reservoir irrigation*

(a) *New Tanks.*—Except for the coastal regions, the rest of the State has got potentialities for tank irrigation. A broad survey of different water-sheds need be undertaken and the water availability from the individual catchments ascertained. The area proposed to be served in the near future by major irrigation projects should be marked out and thereafter surveys undertaken on probable sites for minor tanks. Priority could be determined on (i) suitability of the site from the point of view of cost, (ii) availability of already developed land for irrigation and (iii) peoples' enthusiasm for the scheme.

(b) *Repairs and restoration of tanks.*—At present, there is no definite system by which repairs and restoration of existing tanks is taken in a regular manner. It is necessary that Government acquire rights in all the minor tanks under Anchal Shashan. After this has been done, a regular yearly programme could be drawn out for their repairs and restoration. Once these tanks have been rehabilitated, they could be handed over to the Panchayats.

If the transfer of these tanks to Government is likely to be delayed, Government could requisition these works for a certain period by promulgating an Ordinance. Similar steps were taken in the neighbouring State of Madhya Pradesh in 1948 under the Madhya Pradesh Amendment Act, 1948.

(c) *Bunds.*—Bunds for conserving soil moisture would generally be useful for dry cropped land. Due to good rainfall conditions, paddy is grown even in uplands. For wet crops, direct irrigation is more profitable than more retention of soil moisture. There is no doubt that bunding would improve the yield of unirrigated paddy, but the scope for this kind of work is limited. In the large acres that are being newly reclaimed, where there is no immediate likelihood of direct irrigation being arranged, contour bund should be useful.

(iii) *Irrigation from ground-water*

(a) *Wells.*—In the coastal districts, ground-water availability should assure continue sinking of wells. In the uplands water supplies on wells could be increased by deepening or blasting the well bottoms.

The overall prospect of increasing well irrigation and making it popular would depend upon the following main factors:—

(i) A change in the cropping pattern.

(ii) General improvements in the socio-economic condition of the people by progressive development and education.

(iii) Formation of cooperative organisation for improving the marketing and distribution facilities.

All these processes take time, and it would be difficult to increase well irrigation on any large scale except in pilot areas where new cropping system with other facilities is introduced on an experimental scale.

(b) *Tubewells.*—From the data and experience gained on the sinking of tubewells, there is little doubt that good ground-water would be available in certain parts of the coastal districts for the successful installation of tubewells. The areas could be finally confirmed on the completion of exploratory drillings under the All India Ground-water Exploration Programme.

The main difficulty has been the lack of sufficient demand for tubewell water. It is, however, generally opined by the Agricultural Experts that if early paddy is grown under irrigation from tubewell water (which would be mainly needed at the time of raising seedlings and transplantation operations) followed by a regularly irrigated rabi crop like wheat and combined with growing of cash crops like sugarcane and vegetables, it should be quite possible to make tubewell irrigation popular and remunerative. Raising of groundnuts as an irrigated rabi crop has also been suggested from some quarters. Yet another alternative would be to grow second crop of paddy.

Success on tubewells as also on other irrigation schemes would depend a good deal upon the availability of cheap hydro-electric power. Power generation on Hirakud Dam holds out good prospects for the districts of Cuttack and Puri. Similarly, Ganjam District should be served from the Machkund. Water lifting may be attempted in groups of tubewells and wells suitably situated near the transmission lines. Location in groups would reduce the maintenance expenditure.

(4) RECOMMENDATIONS

(i) *Preliminary studies.*—Before any stream is tapped for irrigation, it is very essential that water flow conditions have been previously observed closely. Particular care should be taken in finding out the minimum flow. In addition to the stream-flow observations, it is also necessary to carry out detailed study of the drainage lines and mark out the general lie of the water shed. Such studies would indicate the directions in which intensive levelling need be done.

(ii) Earthwork on the water channels from the outlets of the canals should be undertaken along with the main construction. At present, on several works the construction of water channels has been left over with the result that full benefit has not accrued on completed works.

(iii) *Minor Irrigation Laws.*—Under the GMF Scheme, a number of minor irrigation works were constructed, some by the P.W.D. but mostly by the Revenue Department. Of these works, 25% contribution from the people has been made obligatory. Works under private ownership continued to be the property of individuals even if these were rehabilitated at State cost. The works newly constructed (like the weir schemes) were the property of Government. Irrigation from both class of works was, however, left to the cultivators.

Till recently no obligations had been imposed upon the cultivator to make use of water available from these sources. It was not known whether the beneficiaries would be required to pay any water rate or betterment tax or both. Government have now in view to survey the commanded area of these works and assess them to water rate as per provisions of the Irrigation Act in force in the State. It is understood that the Anchal Shasan Act provided for the transfer of these tanks to the Panchayats who will be responsible for the maintenance of these works.

The exact provisions of the Act are not known, but it is suggested that the following measures be considered in order to ensure maximum utilisation of the irrigation water;—

(a) levy of a water rate and betterment tax either as a permanent assessment or on annual basis would not only help proper development of irrigation from the newly constructed sources but would also ensure construction of works of positive utility. In the case of minor works constructed under the Revenue Department where irrigation supplies may not be assured, perhaps the scale of levy might be lower in comparison to that applicable to bigger works.

(b) The system of compulsory irrigation as visualised in the Irrigation Amendment Act of 1945, Madhya Pradesh need be introduced in this region also for expeditious development of irrigation as water is required in Orissa mostly for supplementary irrigation as in Madhya Pradesh.

(iv) *Introduction of New Agricultural Practices for Development of Irrigation.*—The introduction of regularly irrigated Rabi crop seems to be a necessary condition for the quick development of tubewell irrigation. If an early variety of paddy crop is sown under irrigated conditions followed by irrigated wheat, it is possible that with the proper application of manure and fertilisers, each acre of land may yield much more food crops than if it were allowed to grow a single unirrigated crop of paddy. For the early variety of paddy liberal application of irrigation water at the time of raising seedling and transplantation would be of great use. These two food crops could be grown along with cash crops like sugarcane, groundnut, etc., etc.

If in selected plots of 25 acres under each of the State tubewells intensive cropping practices are introduced, it may be possible to demonstrate the optimum use of water and the people would be encouraged to take to irrigation from tubewells.

(v) *Development of Tank-cum-Anicut Irrigation.*—The system of supplementing anicut irrigation by tank irrigation and *vice versa* needs to be developed on a systematic basis. In normal years the average flow of water is sufficient to irrigate the ayacut under it. In years of scanty rainfall supplemental irrigation from reservoirs constructed in the head-reach of the valley goes a long way to stabilise irrigation from the anicuts. Similarly the carry over in the reservoirs supplies the necessary water for raising of seedling and transplantation operations when the stream flow is very little. In average years and years of heavier rainfall the reservoir water is conserved and could be usefully utilised for irrigation of Rabi crop. Thus the average discharge in the stream and the storage jointly contribute to the irrigation capacity of the system as a whole. These factors are perhaps not being adequately taken care of in the design or choice of minor irrigation works falling under this category.

There is the other alternative in which the anicuts feed a system of tanks by diverting the flood water during rains through high level channels. This method is resorted to whenever the independent catchments are not effective in filling the tanks. Since the rainfall here is quite heavy, the occasion for this should not normally arise. In driver reaches, however, adoption of this system might be found useful.

(vi) *Chain irrigation.*—At certain places, attempts have been made to construct a number of tanks in the same valley. Chain irrigation is a well-developed technique extensively practised in Mysore and Hyderabad. The storage capacity of each unit contributes to the irrigation capacity of the whole system, and the irrigation benefits are dispersed across a large area of the water-shed. Where topography so permits, the possibility of chain irrigation could be explored, as such a system would not only increase the area of benefit but would also improve the tank duty of the whole system. It would serve the important purpose of benefiting large area by a coordinated system of minor tanks.

(vii) *Design of anicuts.*—Two factors in the design of anicuts deserve consideration:—

(i) A high level anicut which would block the normal cross-section of the stream should ordinarily be avoided, as there would be the danger of outflanking. Attempt should be made to get command from low level weirs. If it becomes unavoidable to construct a high level weirs adequate number of openings fitted with plank shutters should be provided in the weir wall to prevent silting of the river bed upstream.

(ii) The irrigable capacity of the diversion works should be judged from the October-November discharge in the stream and not from the average flow during the monsoon period.

(viii) *Improvement of water conveyance and water use under Major Irrigation Projects.*—In Orissa State, a major irrigation project of Hirakud Dam is nearing completion and large areas have been thrown open to irrigation water. Full use of the released water is, however, expected to take some time. It is suggested that in selected areas under command of the Hirakud canals an elaborate system of water-courses should be constructed as a State enterprise under the Minor Irrigation Programme. This would not only demonstrate to the cultivator the correct use of irrigation water but would also ensure bigger areas being served by the same quantity of water. Once the cultivator takes to wasteful practices, it becomes very difficult to remedy it at a later state.

(ix) *Peoples' participation.*—In all minor irrigation works, it is felt that betterment levy should take the shape of peoples' contribution. It is necessary that the actual beneficiaries are associated with the planning and execution of a minor irrigation scheme at every stage. This will ensure quick development of irrigation after the work is constructed. People could be told in advance their individual share in the total betterment tax. They could be made to contribute to that extent in the very beginning in the shape mostly of labour and also in cash.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON ERSTWHILE MADHYA PRADESH STATE

(1) Outstanding Features

Madhya Pradesh has varied climatic conditions. The rainfall is not uniform everywhere nor are the soil conditions same. Annual figures of rainfall vary from some 50″ to the east of Nagpur to only 30″ in Berar. On the basis of rainfall and soil conditions, the State can be divided into three regions. These regions have different cropping arrangements. Hence, their requirement for irrigation water is varied. The east region covering the Chhatisgarh area has red sandy soil. In spite of 50″ rainfall, the absorbant nature of the soil is responsible for almost a permanent demand for irrigation in paddy. Old irrigation works are mostly concentrated in this area and have been doing satisfactory irrigation of paddy.

The second region is made up of the northern districts of Jubbalpur and Sagar where 40″ is the average annual rainfall. The soil is medium black. The clay content of the soil is sufficient for retaining moisture. Hence, in a year of normal rainfall the need for artificial irrigation is not felt always.

The third region is to the west and mainly comprises of Berar where only 30″ annual rainfall is recorded but the soil is medium black cotton.

In a normal year, a well-distributed rainfall should be sufficient for satisfactory cultivation, but keen demand for irrigation water arrangement is felt when the monsoon either begins very late or terminates unusually early. A spell of dry weather in mid-monsoon is not so harmful as a late start or an early cessation of the monsoon period. These deficiencies can be made up by timely storage of the rain water or if the rain-fed streams are diverted particularly near the hills where more rain has fallen.

The sub-surface geology is not very favourable for abundant supplies of groundwater. Only in some portions of alluvium basin of Narbada, prospects for largescale groundwater irrigation have been explored. At other places, local groundwater availability in small quantities has been observed. The quantity available depends upon the location of porous strata near streams that could be relied upon for replenishing the ground-water supplies.

(2) PERFORMANCE

(i) Surface-water storage.—Minor Irrigation Schemes in the State are being executed partly by the Irrigation Department and partly by the Agriculture and Revenue Departments. Irrigation on the old storage tanks in the Chhatisgarh regions has developed very fast after the famine year of 1939-40. Prior to this, the development of irrigation from storage reservoir was very slow. There has been keen demand for water consequent to better prices of foodgrains and also because there have been a series of deficient rainfall years. Irrigation on minor tanks has, however, not increased everywhere. There are many reasons for shortfall or irrigation on minor tanks. Wherever the tanks were owned by big land holders, they have generally been subletting the land to cultivating tenants. Since the latter did not have any direct interest in raising good irrigated crop because of the principle of crop-sharing, they were not very keen to use irrigation water. It was for this reason that when the tanks showed signs of deterioration, the cultivating tenants were not very enthusiastic about repairing the tanks. Since the owner of the tank has some outside business and was not directly interested in irrigation from the tank, its repairs and maintenance did not receive his attention.

Even where big cultivators are not involved and only small cultivators have been jointly owning a minor tank, the idea of co-operative maintenance of such works has not made much impression on the mind of the cultivators. The tanks went out of maintenance and there was no obligation imposed on them—legislative or otherwise—to maintain such works.

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In the recent past, another consideration has also cropped up. In Chhatisgarh, there are quite a number of Malguzari tanks. With the abolition of Malguzari, the rights in these tanks now vest in the State. The cultivators who benefited from these tanks when they were in good condition acquired permanent irrigation rights. Wajib-ul-Arz is a legal document on the basis of which they can always claim irrigation without, in any way, being obliged to Government who are the present owners of Malguzari tanks. The State Government have been considering the repairs arrangement of these tanks, but realising that investment on such tanks would not yield any direct revenue in the form of water rate, they are finding it difficult to invest money on the repairs of these tanks.

On account of heavy rainfall in Madhya Pradesh, the tanks are generally designed to store only a portion of the yield from the catchment. It is very rare that the tanks suffer from the defect of not filling. Diversion of additional catchment is, therefore, not generally needed for augmenting the supplies to a tank.

Desilting has not been tried in the State on any appreciable scale. Wherever capacity has reduced because of non-clearance, the earth that is desilted is mostly used for raising the banks. Care is thus taken not to permit increase in the area submerged due to 'storage'.

Wells.—In the Hoshangabad, Sagar, and northern parts of the Jubbalpur Districts, the groundwater availability is generally more than what is at present utilised. Well irrigation for paddy crop is rarely resorted. Even wheat crop cultivation has been possible without irrigation. Major portion of the tract has got clayey soil, hence is capable of retaining moisture long after the rains. Since these areas have rainfall of 45–50 inches and also there are winter showers, the cultivators do not usually take to water lifting from wells. At a few wells, water lifting is done for one or two irrigations during January and February. This is too meagre a requirement. During the remaining part of the year, no use is made of the water in the well. In the Sagar District, plentiful groundwater availiability is indicated by appreciable water flow observed in the streams. It is quite easy to divert the stream flow. The cultivators find it convenient to arrange for the necessary soil moisture by constructing field embankments. So even in Sagar, in spite of a good groundwater availability, not much use is made of wells.

In the Chindwara, Nimar and Amraoti District well irrigation is extensively practised. The groundwater storage is mainly in the decomposed rock. Groundwater supplies on many wells have improved consequent to blasting of the well bottoms. Boring, however, has not been equally successful because the fissured rocks in these tracts dip vertically and there is consequently not much possibility of tapping many fissures in a vertical boring. Blasting, on the other hand, arranges some water storage.

Among the water lifting appliances, Charas is the most popular. Bullocks operate upon a leather moat for lifting water. Of recent origin is the use of small pump sets. These have been increasingly installed in the districts of Chindwara, Hoshangabad, Nimar and also in the districts of former Berar. Irrigation of garden crops has been the most popular use of wells that have been powered with small pumpsets.

Diversion works.—Under minor irrigation, there are very few permanent diversion works. They generally comprise of earthen embankments thrown across streams and nallas. In the Nimar District alone, a few masonry structures are noticed. Most of these structures have been outflaned. Some of them have been damaged and washed away also. These masonry structures were defective in so far as they completely blocked the normal cross-section of the stream.

Some permanent structures were constructed under the Village Project Scheme in Jubbalpure, Sagar, Mandla and Nimar Districts.

A diversion work has also been completed in the hilly area of Mandla District. So far, no defection in the irrigation arrangement on account of excessive silt charge has been noticed.

The irrigation capacity of the diversion works in the northern districts has been fixed with respect to the post monsoon flow observed in the streams. This is a sound practice, as these works are essentially meant for irrigation of the rabi crop. Except in very dry years, more or less steady discharge flow has been observed and generally it has been possible to work up to the forecast figures of irrigation.

(3) PROSPECTS

The possibilities for increasing irrigation benefits on the existing schemes are quite evident particularly by improving the water conveyance and by adopting efficient arrangement for water distribution. For irrigation to paddy crop, the water is at present invariably conveyed from field to field with the result that a good deal of water is wasted. If irrigation water is conduced in regular waste-courses, water can be conserved and used for expanded irrigation. Water is stored at the tanks at considerable cost. Possibilities of lining the water channels need, therefore, be examined. Water saved consequent to improved methods of conveyance and better distribution arrangements will be primarily available irrigation of intensive cultivation and for the growing of cash crops.

In the paddy tracts of Chhatisgarh, the works are designed on the basis of September and October flow that was observed in the streams. The September and October flow, however, fluctuates very widely depending upon the incidence of rainfall during the monsoon season. When, therefore, there is failure of rainfall in the September months and irrigation is in great demand, the post monsoon flow available for irrigation is also generally much below the irrigation capacity of these works. In such tracts, therefore, it is not always possible to work up to the maximum irrigation capabilities from the diversion works. For paddy irrigation it is felt that the system should be storage-*cum*-diversion.

In Berar and Nimar Districts, there is good possibility of increasing the area under cash crops by lift irrigation. With increasing availability of cheap power from the proposed. Power Plants, lift irrigation is likely to become popular.

Bunds.—There is good prospect for construction of bunds in the northern districts of Madhya Pradesh that could conserve both water and soil. In the districts of Sagar, Jubbalpur, Narsinghpur and Hoshangabad, wheat is extensively grown under unirrigated conditions. There is the general practice to conserve and moisture in the soil by extensive bunding instead of direct irrigation. In Sagar and extreme north of Jubbalpur, big field bunds are in existence which impound water from their own catchments and often submerge large areas. After the rains, water is drained out and wheat is sown in the tanks bed. The soil is black and contains high percentage of clay, which can retain moisture. The crops grown in the tank bed often give good yield of corp.

There is another system of bunding which is practised in Jubbalpur and Narsinghpur. This area is locally known as the Haveli tract. The field bunds here are smaller in size than those referred to in last para and have very little catchment of their own. They trap the rain water directly falling on the fields. Sometimes, however, recourse is taken to artificial flooding from a river or stream. Temporary earthen embankments are thrown across the stream during the rainy season. The flood waters rush into the bunded fields in a short time till the embankment across the stream breaches. This water is trapped into the bunded fields and is extremely beneficial for growing wheat crop in the post-monsoon season. There are two main advantages of the diversion of flood water in this manner. One is that the flood water brings with it large quantities of silt which acts as a manure. The other advantage is that sudden flooding arrests the growth of weeds. In absence of artificial flooding, the weeds have a tendency to grow as the rain falls. Under conditions of sudden flooding, the weeds decay and contribute to the manurial value of the soil.

There is a great prospect for continued construction of both types of bunds in the wheat zone of Madhya Pradesh. It may, however, be added that these bunds are not strictly contour bunds specially in the Haveli tract where large stretches of flat land have been bunded in the above manner.

(4) RECOMMENDATIONS

The State has been experiencing very serious difficulties in the recruitment of staff, both subordinate and officers. Till recently, the State of Madhya Pradesh has been having a combined Buildings, Roads and Irrigation Organisation. Since the State has embarked on a very big irrigation programme, acute shortage of experienced irrigation staff has been felt at all stages. There are not many officers with irrigation experience to cope up with this programme. The State has been trying to get officers from outside also.

Regarding the staff at the subordinate level, the shortage is still greater. There was only one Engineering School at Nagpur which could not meet the requirements of the whole State in the different branches of Civil Engineering. The staff had to be recruited from schools in U.P. and other neighbouring States.

The State has in view to start short-term training centres at Amraoti, Rajpur and Jubbalpur. A similar short-term training scheme is under consideration of the Community Projects Administration. It is strongly urged that all these training schemes be brought into effect as early as possible.

Under the Village Project Scheme, it has been suggested to the Irrigation Department that the surplusing arrangements of minor tanks need not be designed for maximum floods. They could, without much risk, be designed for only half these floods. The abnormal floods could be disposed of through by-washes located in the flanks or breaching sections. The arrangement was accepted by the Irrigation Department in a number of cases, but so far no definite instructions have been issued.

The idea is to keep by-washes 6″ to 1′ higher than the main waste-weir. Similarly, the breaching section is also to be provided where the ground level is 6″ to 1′ higher than the waste-weir level. The by-washes of the breaching sections would not come into operation during ordinary floods. When there are abnormal floods, the by-washes and the breaching sections could successfully dispose off the flood without any appreciable damage occurring to the dam embankments.

There has been increasing tendency to instal pump sets of much higher horse-power than what is really required. A smaller horse power pump-sets would attend to the irrigation requirements by running a larger number of hours. This may increase the labour required for irrigation, but would be a more satisfactory arrangement for improving the load factor of the electric power supply. With a high horse power installation, a greater allocation of power is reserved without putting it to full use. It is, therefore, recommended that horse power of future pump installations need be examined with greater care.

REPORT OF THE MINOR IRRIGATION COMMITTEE ON UTTAR PRADESH

(1) IRRIGATION PERFORMANCE

(i) Quite a variety of minor irrigation schemes have been completed in the State. The hill channels in the north, large-scale surface and ground-water utilisation in the alluvial plains and water storage in tanks and on field bunds in the southern part of Bundhelkhand have been the outstanding items of minor irrigation constructions. Maximum irrigation benefit is estimated on masonry wells. Besides construction of new wells, existing ones have been improved by boring the well bottoms. Blasting has not been necessary except in the two Districts of Jhansi and Mirzapur where rocky strata is come across at shallow depth. Large-scale tubewell constructions have been undertaken. 1:5 cusec discharge tubewells have been completed by the State and are being run as State irrigation work. Constructions of smaller-size tubewells have been taken up by private parties. As individual owners of large farms are not numerous, construction of tubewells by cooperatives has also been initiated. With the popularity of ground water use, water lifting has been increasingly adopted. While purchase of Persian wheels is being financed, taccavi loans are also offered for the purchase of small-size pumpsets. As electricity has not reached all rural areas in the State, diesel-driven sets are also being installed. Diesel running has not been very successful, as it has not been possible to arrange proper maintenance everywhere. Recognising the need for lift irrigation, the State has organised Governmental running of a large number of diesel-driven pumpsets to do lift irrigation from tanks and streams.

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(ii) The State Irrigation Department has carried out extensions on the existing irrigation system. Future expansion of irrigation by extension of channels is restricted on account of insufficient water supplies. So far, there are no storage dams on the rivers that flow from the Himalayas; hence irrigation has to be necessarily limited to the water supplies available in the rivers. Such unirrigated tracts where groundwater availability has been established, are being increasingly served by a net-work of State tubewells. Arrangements for rural electric supply are in hand, and it is hoped that on their completion, all groundwater worthy areas would have assured irrigation from tubewells.

(iii) The southern portion of the State covered by the Districts of *Jhansi*, Jallan, Amirpur, Banda, Mirzapur etc. is underlaid with rockly sub-strata; hence, groundwater availability is rather doubtful. The State has, however, completed a large number of dams on the streams from the Vindhya that pass through this area. For-all-the-year-round irrigation, it was necessary to store rain-fed water supplies in the streams. In a good portion of this tract, the soil is of a firm texture that can retain moisture. For such areas bunding has been extensively done. Such soils are locally called "Mar" and "Kabar". They require only Paleo watering and do not need a Kor irrigation. At other places where the soil is different and a Kor watering is essential, storage reservoirs have been built.

(iv) Besides above irrigation arrangements, the State has also undertaken improvement of drainage of such parts which have relatively flat ground slope. Existing drains have been re-graded and a complete drainage system completed, with the necessary drainage sluices. At quite a few places, new drains had to be constructed and adequate outletting arrangements made to enable timely rabi cultivation. Land that is reclaimed has contributed to additional food production with minimum of expenditure.

(2) PRODUCTION

(i) In the First Plan, the area benefited from the constructed of hill channels has been only 6,000 acres. For the convenience of the people living in the scattered villages of the hilly area in Almora, Nainital, Tehri-Garhwal and Dehra Dun Districts, it would be desirable to intensify the construction of hill channels. All such constructions will have to depend upon the diversion of streams water. With the available water supplies there appears good scope for irrigation expansion.

(ii) Similarly the work done so far on drainage improvements had better be expanded to cover the entire State. Luckily, the construction of surface drains can be depended upon for adequate disposal of the rain water. Hardly any ill-drained area need be dealt with by seepage drains or would need the construction of tubewells.

(iii) Not much area had the benefit of bund construction. Contour bundies constructed since 1951-52 have served only an area of 30,000 acres. Extensive areas of Bundhelkhand with proper soil texture and favourable country slopes could be completed with contour bundies. These may be increasingly undertaken economically in tracts that are thinly populated and do not hold out a definite promise for agricultural development from rather costly water storage arrangements.

(iv) In spite of the fact that construction of open masonry wells has been encouraged now for many years, the number of wells completed has shown a decline from 9,644 in 1951-52 to only 5,729 in 1954-55. In 1953-54, only 4,521 wells were completed. In view of this decline and also because the State has completed a large number of wells where there are good chances of additional water supplies being obtained, it may be desirable for the State to concentrate on improving the water availability of the existing wells. With this object in view, it may be necessary to organise intensive boring of open wells. A 40—50 feet drilling and the location of 10 or 15 feet of filter should have more than double the discharge from most of the masonry wells. Expenditure on such boring would be a fraction of what need be spent on construction of new wells an equal increase in water resource. Such wells that are bored could be installed with pumpsets capable of irrigating 20—25 acres.

(v) For the flat areas of the eastern districts, quite a few water-spreads are observed. Installation of pumping sets should make available irrigation water supplies to nearby land. Such lift irrigation schemes will have to be either a State venture or may have to be organised through Co-operative Societies. The State is reported to have arranged lift irrigation on a few tanks. It may be worth while examining lift irrigation possibility on all tanks.

(3) RECOMMENDATION

(i) A large number of scattered private works have been financed. It would be desirable to keep a proper record of all such works. This would be helpful in the examination of any new requests for finances that are received. In case of tanks and drainages that are completed for a group of cultivators and which are not sufficiently big to be taken over by the Engineering Department for maintenance, it may be desirable to draw out proper standards for efficient maintenance of the works. These standards could be periodically checked at site by qualified technical hands and in case any defect is detected, the beneficiaries could be asked to rectify the same.

(ii) The areas benefited from the large number of works are at present being recorded in the normal routine duties of the revenue officials. These are again verified only when other village statistics are checked by superior officers. For a more positive assessment of the benefits it may be desirable for the State to carry out some randum sample survey. This survey may be entrusted to a group consisting of a Statistician and officers of the Irrigation and Agriculture Departments.

(iii) Large scale tubewell constructions have been carried out by the State on a standard design of 6 inches tubewell that was evolved over 20 years back. This design was best suited for the western districts where required depth of aquifers was met with in a shallow depth of 250—300 feet. As tubewell constructions are being extended to areas lower down the Ganges valley, necessary aquifers are obtained only by drilling deeper depths. For the conveyance of water found at deeper depths, it may be desirable to use pipes bigger than 6 inches. Similarly, other improvement in design of the standard tubewells seems called for. The State may try to carry out some field experiments with the variety of drilling equipment that they have. A suitable design may bring about economy on the large scale tubewell constructions that the State intends pursuing.

(iv) Tubewells are at present being completed with only one mile length of lined channels. On wells with established irrigation, it may be desirable to extend the lining. The expenditure on lining extension will be well justified by the increased irrigation that would promptly accrue with the water saved consequent to a lined channel.

(v) On the extensive irrigation systems, the State may lay particular emphasis on proper conveyance of canal water and its correct application to the fields. Measures taken elsewhere have brought about an appreciable increase in irrigation. The State may decide to get, these important objectives attained in the CP and NES areas.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON BIHAR

(1) OUTSTANDING FEATURES

Topographically, the State can be divided in three zones of Chota Nagpur, South Bihar and North Bihar. Figure of annual rainfall varies from 40 to 60 inches. Irrigation is primarily needed for any ill distribution of rainfall. Quite frequently, the rainfall is scarce during the period paddy has to be transplanted. Occasional rainfall deficiencies have also been observed during later part of the monsoon commonly in the Hathia Nakshatra when the paddy is about to ripen.

Minor irrigation schemes costing less than Rs. 10 lakhs are dealt with by several Department in the State. Those costing Rs. 30,000 or less are in the charge of the Revenue Department. The Agriculture Department deals with the schemes costing between Rs. 30,000 and Rs. 1,00,000. In this category, however, the Agriculture Department is not permitted to undertake new works that cost more than Rs. 30,000. All works above Rs. 1 lakh are dealt with by the Irrigation Department of the State, like any other medium irrigation schemes.

(2) IRRIGATION PERFORMANCE

(i) **South Bihar Zone.**—The zone may be divided into two parts (a) the Terai area and (b) the flatter country. So far as the Terai area is concerned, the irrigation is mainly done through share, as the slope of the country is very favourable being only of the order of 5–7 feet per mile. Lower down upto 3 feet per mile, the area is irrigated partly by the ahars and partly direct from the pynes or canals. Sometimes, weirs have been necessary in this area. In the flatter country, the irrigation is done exclusively by pynes. Occasionally, one comes across ahars also in this area, but these ahars have every time to be fed by pynes that are taken off from the local streams. Most of the rivers have flashy discharge.

(ii) In Gaya-Monghyr Districts, Sakri irrigation scheme was completed in the year 1950. This scheme was mainly with a view to feed such ahars in this area and also to effect irrigation directly from the area to be irrigated by the ahars & 1/3 by the pynes; the ratio being of the order of 2/3rd of the pynes. The ahars existed before. It was mainly the question of re-distribution of water according to the area irrigated by the construction of canal and small distributions and advantage was taken of the existing pynes wherever available. The new constructions have brought out following salient advantages:—

(a) By the construction of a datum well and head regulator and other ancilliary works, the level of the water at the head is controlled;

(b) Pynes have been aligned on satisfactory levels with a view to giving adequate supply to ahars;

(c) 50,000 acres is the total benefited area. Hence, the average cost would work out to about Rs. 70 per acre.

Similarly, Kumri Irrigation Scheme has been constructed at a cost of Rs. 4 lakhs for the benefit of 2,000 acres by the construction of weirs and pynes.

(ii) **North Bihar Zone.**—The zone may be sub-divided into a number of basins, e.g. (a) Gogre-Gandak basin, (b) Gandak-Burhi basin, (c) Gandak-Begmati basin, (d) Begmati and Kamla basin, and (e) Kamla Kosi basin etc. In these basins, there is a good number of drainage and reclamation schemes which have further been divided into schemes with 3 square miles and less area and schemes with over 3 sq. miles area. There being so many "Chaurs" in this area, a good number of chaur reclamation schemes have yet to be taken up. Total expenditure incurred on the drainage of Chaurs is about Rs. 25 lakhs and the area expected to be benfited on the completion of the scheme is of the order of 78,700 acres.

All drainage works completed in the First Plan are being maintained by the Irrigation Department. In future also, all drainage constructions done by the Irrigation Department will be their responsibility. These schemes are being undertaken under the Bihar Public Irrigation and Drainage Works Act of 1947. This Act provides for recovery of the cost of schemes including maintenance from the beneficiaries. The drainage Schemes have been successful because of the satisfactory outlet conditions that can be arranged in the area. When the river water goes down in the months of October, the Chaur water is outletted to enable cultivators to sow rabi even on the fringes of these Chaurs. A regulator is invariably required for controlling the flood from the river and also for utilising the Chaur water.

(iii) **Tubewells.**—The State had first started tubewell irrigation in the Dehri-on-Sone area. Wells with quite satisfactory discharges were completed along with two miles of water channel on each well. Permanent electric supply was arranged from Dehri. Irrigation on Dehri-on-Sone wells developed fast, but there was a sharp decline as soon as high water rates were applied. Because of the high tubewell water rates, even tubewells completed in the North and South Bihar zones under the TCM

Programme have not been working satisfactorily. The State had appointed an Enquiry Committee which has recommended volumetric sale of water. As a special measure, the State has introduced concessional rates during the current season.

(iv) **Surface wells.**—It has been possible to construct surface wells in both North and South Bihar zones. Predominant alluvial formations in these tracts are responsible for the popularity of surface wells. As the water supply is quite satisfactory, a very keen demand has developed for the installation of small pumping sets on these wells. Though quite a large number of diesel-driven pumpsets have been installed, they are not as popular as those run with electric motors. At places where the irrigation requirements have grown appreciably, the well owners have come up to the Engineering Section of the Department of Agriculture for boring their well bottoms. Consequent to a 50 feet boring and installation of a short length filter, the supplies of water on the wells have grately improved.

(v) **Lift irrigation from streams.**—Some 200 pumpsets were obtained as an emergency measure for installation on rivers. These pumpsets were installed on trollies and could therefore be carried from place to place. In spite of this mobility, the pumpsets have not been popular and at not many places sufficient satta was forthcoming. The State had fixed a minimum guarantee of 75 acres per river pump, but even this could not materialise in a large number of cases. The water channels from all those pumping sites have to be constructed by the cultivators who invariably fail to agree among themselves upon a satisfactory alignment that could adequately convey the pumped discharge of over one cusec.

(vi) **Minor irrigation schemes of the Revenue Department.**—The Revenue Department undertakes construction of works upto Rs. 30,000 under the Bihar Private Irrigation Works Act, 1922. To each Divisional Commissioner, an Executive Engineer is assigned. At each District Headquarters, there is an Assistant Engineer. Similarly, there are Overseers headquartered with the Civil Sub-Divisional Officer. The schemes are usually sponsored by the beneficiaries. The Engineering Overseers of the Circle Inspectors generally frame schemes and the same are put up before the District Irrigation Committee which is presided over by the Collector of the District. No scheme is approved unless the beneficiaries give a written undertaking of paying 50 per cent. of the total cost. According to the provisions in the Act, any work above Rs. 2,500 must be shown to the Assistant Engineer in charge of the District. If the District Magistrate considers it necessary, he may also consult the Executive Engineer attached to the Divisional Commissioners. After the scheme is approved by the District Irrigation Committee, the Collector can accord sanction for any repair or new schemes costing upto Rs. 5,000. The schemes costing between Rs. 5,000 and Rs. 10,000 are sanctioned by the Divisional Commissioners. Repair schemes above Rs. 10,000 upto any limit of Rs. 30,000 are sanctioned by the State Government. The Divisional Commissioners, whenever they consider it necessary, may consult the Executive Engineers attached to them regarding technical feasibility of any scheme which may come upto them for sanction or for onward transmission to Government.

After the scheme is sanctioned, the work is executed under the orders of the District Magistrate, and payments for bills are made either by the Civil Sub-Divisional officers or by the District Magistrate himself after the bills have been submitted by the Overseers or by the Circle Inspector in charge of the work. The rules insist that final measurement for any scheme must be taken by a gazetted officer.

After the schemes are finally executed, the works are entrusted to the Gram Panchayats for maintenance. If there are no Gram Panchayats in a particular village or locality, some *ad-hoc* Gram Panchayats are set up under orders of the District Magistrate and they are entrusted with the work of maintenance. The law provides for recovery from beneficiaries of this maintenance cost as well. For this, the Gram Panchayats who are entrusted with the maintenance, are required to come up to the Collector for funds which are ultimately to be recovered from the beneficiaries according to the aportionment that is decided by the Collector.

(vii) **Schemes of the Agriculture Department.**—There is an Agricultural Engineer of the rank of Executive Engineer attached to the Director Agriculture. There are Range Assistant Engineers posted to the headquarters of the Deputy Directors of Agriculture. Their jurisdiction is identical to those of the Divisional Commissioners. Subordinate to the Assistant Engineer are the District Engineering Supervisors of the rank of senior Overseers who are attached to the District Agricultural Officers. Their jurisdiction extends over the whole of each District. In each Civil Sub-division, there are Engineering Overseers attahced to the Sub-divisional Agricultural Officers.

The schemes are sponsored either by the beneficiaries or by the local officers of the Agricultural Department. The Engineering Overseer of the Sub-division concerned frames the estimate and then it is approved by the Sub-divisional Agricultural Officer and put up before the Sub-divisional Agricultural Advisory Committee which is presided over by the Civil S.D.O. After the scheme is passed by this Committee, it is sent to the District Agricultural Officer who gets it scrutinised by the District Engineering Supervisor and then puts up the scheme if found feasible before the District Agricultural Advisory Committee, of which the District Magistrate is the President. After the scheme is approved by the District Agricultural Advisory Committee, it is sent up to the Deputy Director of Agriculture who obtains concurrence of the Range Assistant Engineer and then, if technically accepted by him, he forwards the scheme to the Agricultural Engineer for scrutiny and for onward transmission to the Director of Agriculture. When the Agricultural Engineer is satisfied about the technical aspects of the scheme, he forwards the same to the

Director of Agriculture, who obtains administrative approval of Government and then the scheme is taken up for execution only after this approval. The technical supervision, control and construction is also exercised by the technical officers referred to above.

After the schemes are completed, the maintenance work is entrusted to the Gram Panchayats. Village Headmen or *ad-hoc* Gram Panchayats, Cooperative Societies, etc. which may be in existence in the locality. Recovery to the extent of 50% from the beneficiaries is made for all medium irrigation schemes.

(3) IRRIGATION POSSIBILITIES.

(i) In the Chota Nagpur zone, there are many possibilities of constructing minor irrigation schemes mainly for water storage. Such schemes would have irrigation capability of about 2,000 acres each. It should even be possible to construct weirs across the streams, as quite frequently discharges of 2–3 cusec have been observed during October (Hathia nakshatra) for a square mile of catchment. It should be possible to construct minor irrigation schemes in this zone at an average cost of Rs. 250–300 per acre.

(ii) Through proper drainage of chaurs in North Bihar it should be possible to reclaim about 2 lakh acres. The cost per acre is not likely to exceed Rs. 75.

(iii) Quite a few streams have water flowing at low level. Hence for full utilisation on the neighbouring land, lift irrigation has to be arranged. Water lifting from rivers should evidently offer good prospects of irrigation increase. Unfortunately, the State has not met with success on the scheme so far attempted. On almost all the river pumping schemes, the State had planned for large quantities of water lifting. Proper use of large quantity of pumped water required prior construction of long lengths of channels. In future, the State may as well try water lifting on smaller scale that would not require long length of channels. In fact, it may be a good scheme to insist on the groups of few cultivators in the command of such pumping proposals to complete their channels before a small pumpset is arranged.

(iv) With a more rational rate and adequate maintenance of the water courses, the tubewell irrigation should become more popular. It is also important to arrange permanent supply of electricity. Uncertain supply of power does not create necessary confidence in the cultivators whose irrigation requirements come up quite suddenly.

(v) Quite a high percentage of the works handled by the Agricultural Engineering Department is in the nature of constructing masonry weirs at places where the cultivators were building earth embankments from year to year. These pucca constructions stabilise the irrigation to a fair extent. This work is likely to be continued for extending the assured benefit to increasing areas.

(4) RECOMMENDATIONS

(i) As the irrigated area in Chota Nagpur Zone is only 2% of the culturable area (as against 18—20% irrigated area in South Bihar), it would appear desirable to investigate all possible sites for construction of minor irrigation works. A systematic survey need be undertaken. These surveys should be of the upland areas which cannot be irrigated from the few major and medium schemes proposed in the Chota Nagpur zone and which can irrigate areas lower down in South Bihar.

(ii) On the analogy of what has been achieved on the Sakhri and Kumri Irrigation Schemes, it would be worthwhile investigating all such cases of ahars and pynes whose working could be integrated for a more assured water supply through properly aligned water channels.

(iii) Increasing use of sub-surafce water should be encouraged by financing the purchase of pumping sets, persian wheels and other water lifting appliances for installation on existing masonry wells. In fact, it would be an advantage to encourage these installations and even slow down the construction of new wells. In this manner, a fuller use of the water resource on six existing wells would be possible at a cheaper cost.

(iv) Fuller use of tubewells would require a concerted attempt at introducing new cropping pattern in the tubewell areas. Hot weather cultivation needs special attention, as a large percentage of constructed tubewells are idle during hot weather, because cultivators are even now persisting with their age-old practice of cultivating only rain-grown crops.

(v) On the numerous weirs that are being completed in masonry instead of the earth embankments, the Agricultural Engineering Department need take greater interest on getting the marginal bunds and on water channels satisfactorily completed. Though only earthwork is required in the marginal bunds and water channels. It is very important that those are attended to, otherwise all the money spent on masonry constructions of the weir is not fruitful.

(vi) Works are at present started by the Agriculture and Revenue Departments on receipt of complaints or representations. It would therefore appear that the new improvements are likely to be undertaken only where the people are more vocal. It would be desirable to examine all the irrigation records of ryots to ascertain those particular works where the irrigation has been dwindling. Such places should be tackled first.

(vii) Before making the weirs permanent, it may be desirable to examine the use of stream water that is being made or is projected upsteam of the site. Such a study may also bring out the possibility of combining several small weirs at one place.

REPORT OF THE MINOR IRRIGATION COMMITTEE ON WEST BENGAL

(1) OUTSTANDING FEATURES.

(i) Irrigation is relatively new to West Bengal. The two major projects of D.V.C. and Mayurakshi have only recently been completed. A small-scale water storage at local low lying places has been in vogue from before. As a result of the permanent settlements, practically all such tanks were in the hands of private owners (landlords). Most of these landlords had settled out the agricultural lands with tenants but had retained the irrigation tanks which were in common use, in their *khas* possession. This resulted in the fact that the landlord had little or no interest in maintaining the tanks, while the tenants not being owners had no right to do so even when they had the means of re-excavating the same. As a result, a very large percentage of irrigation tanks fell into disrepair. The Bengal Tanks Improvement Act of 1935 was designed to meet the situation. The Tank Improvement Section of the Department of Agriculture has been handling the tank irrigation schemes.

(ii) All small irrigation schemes costing Rs. 10,000 and below, including lift irrigation by pumping plants are being handled by the Joint Director of Agriculture (Engineering) in the Directorate of Agriculture. Public works of minor irrigation schemes costing less that Rs. 10 lakhs but above Rs. 10,000 are being executed by the Directorate of Irrigation & Waterways. Irrigation by small storage of water or by diversion from streams and even lift irrigation have been popular in the north and central parts of the State. In the south mainly in the districts of Midnapur and 24-Parganas drainage difficulties have been quite recurring with the result that large number of schemes have been dealt with for improving the drainage.

(iii) The State has a good annual rainfall, but quite frequently the rainfall distribution is not favourable for the cultivation of paddy. Irrigation arrangements are constantly require for tiding over rainfall deficiencies.

(2) IRRIGATION PERFORMANCE

(i) The Bengal Tank Improvement Act provides for the Collector to notify the owners/possessors of the derelict irrigation tanks to improve the same and in case they do not or cannot do so, to take over the tank himself or authorise a co-owner, a cooperative society or some other suitable person for carrying out necessary improvements. It also authorises the Collector to carry out the improvements and to recover the cost incurred therefor for over a period of 20 years by imposing a cess on the owners of lands which get benefit of irrigation from such tanks. The main difficulties encountered in several areas of tank improvement work in the State are:—

(a) The tanks are usually small and scattered over a very large area. It is not usually possible to take up several tanks within a small area in any particular season, as sufficient number of local labour is not available for executing more than one or two schemes. On the other hand, if imported labour is used, the cost goes up considerably. It has been the policy of the Tank Improvement Department to get such works done by the local people as far as possible, as this provides employment to local agricultural labour during the slack season.

(b) For reasons stated above, the individual projects have to be taken up in dispersed areas. A small strength of staff has to be maintained for making out initial estimates and also for supervision of the excavation work.

(c) It has been observed that though hundreds of applications are received from cultivators in different parts of the State for improvement of irrigation tanks in the respective localities and considerable cooperation is available during the period of excavation of tanks, when the excavation work is completed and the time comes for payment of water rates, numerous applications are received claiming exemption from payment on grounds that some of the assessed lands either do not need or do not get irrigation.

(d) In a small number of cases, some opposition is also obtained from a limited number of beneficiaries. This is because in the case of tanks not wholly derelict, some water is retained which can give irrigation to lands in immediate vicinity. Such irrigation is obtained by the beneficiaries concerned without the payment of any water rate. If for benefit of the other beneficiaries, the tank is taken over by the Tank Improvement Department, they also become assesses and have to pay the water rate. Whenever, therefore, any tank of this class is proposed to be taken up, some such people come up with objections against the necessity for improving the tank.

In spite of the above difficulties, the Tank Improvement Department has been able to improve over 2,000 tanks at a cost of Rs. 100 lakhs between 5 years from 1951 to 1956. The area benefited is estimated at 92,894 acres.

(ii) *Small irrigation works of the Agriculture Engineering Section in the Department of Agriculture.*—(a) Between 1951 & 1956, 2692 schemes costing less than Rs. 10,000 each were tackled at a cost of Rs. 86·66 lakhs for the benefit of 8,35,755 acres. These do not include the benefit of 35,000 acres irrigation that was brought about by the Agricultural Engineering staff of the Department of Agriculture through installation of 735 pumpsets between 1951 and 1956. The small works have generally been for the re-excavation of channels in the ill-drained tracts of the State. Once they are properly cleaned and graded, they serve the dual purpose of drainage and irrigation. The Joint Director of Agriculture has been offering advice and guiding the Sanghas that are made up of representatives from 3 or 4 villages which even lie in the two zones. The beneficiaries have not been able to desilt such channels for even 10 years in some cases. Once the excavation is done, the Sangh has been successfully carrying out the working of sluices that are required for regulation for the dual purpose of drainage and irrigation.

(b) The Agricultural Engineering Section has also been responsible for the supply of pumpsets and their later maintenance. Hiring of Government owned pumpsets has been suspended and replaced by direct supply provided that 50% of the total cost is initially deposited and the balance is paid up in another year.

(c) Pumpsets have been increasingly popular in the districts of Midnapur and 24-Pargannas. They are being used for lifting water from tanks which are situated at low points. The pumped water has, therefore, to be delivered over a lengthy rising main. Not many channel constructions have been possible with the result that the benfit from the pumpsets is rather restricted.

(iii) *Small works in the Directorate of Irrigation and Waterways.*—(a) Works costing between Rs. 10,000 and Rs. 10 lakhs are all handled by the Department of Irrigation & Waterways. Between 1951 & 1956, 137 schemes were completed, 44 of which were for irrigation and the balance 93 were for drainage. Irrigation benefit was thereby arranged to over one lakh acres and the maximum area improved by drainage schemes was of the order of 3.35 lakh acres.

(b) Drainage schemes are generally confined to the lower parts of the Midnapur District and 24-Pargannas. The maintenace cost of all the completed drainage schemes including that of pumping at Sonerpur are at present being met with from Government revenues. The areas of complete and partial benefit on any drainage scheme are usually assessed by the Irrigation Department. Thereafter these are also verified by the Agriculture Department before the scheme is finalised. The Irrigation Department is able to check the area at different stages during the period of construction. No measurement is done to the area benefited on drainage schemes like what is being done on 11 out of the 27 irrigation schemes completed by the Irrigation Department.

(c) Improvement levy is being imposed under Section 10 of the Bengal Development Act of 1935 in respect of areas under the command of the old Damodar Canal and also in respect of a part of the commanded area of the Mayurakshi Reservoir Project. Consequent to the imposition of betterment levy in such tracts, it is likely that the minor irrigation schemes will gradually get into disuse. This is likely because the beneficiaries who have to compulsorily pay the betterment levy will not care to look after the maintenance of minor irrigation works.

(iv) *Tubewells.*—No State tubewell irrigation schemes has so far been launched except the construction of a few tubewells that were undertaken in the Community Project block at Phulia. Different agencies have been employed for carrying out the drilling, the pumps installation, the electrification and the construction of tubewells water channels. Phulia tubewells are likely to do useful irrigation if a single agency is entrusted the responsibility of constructing the tubewells complete with water channels and powered with an assured electric supply.

(3) IRRIGATION POSSIBILITIES

(a) In the northern district of Jalpaiguri, the rivers coming out of the hills have been shifting their course quite frequently. Construction of a major work may not be found feasible. For irrigation relief, small works may have to be projected. In view of the fast slopes and the meandering nature of the rivers, the new schemes may have to be linked up with soil conservation measures and river training works.

(b) The alluvial tract made up of districts of Murshidabad, Nadia and 24-Parganas should offer possibilities of using groundwater for irrigation. Already tubewells have been declared successful in Phulia CP Block and at the Haringhatta State Farm. Further explorations are planned by the Groundwater Exploration Organisation of the Ministry of Food & Agriculture. On the basis of these results and upon the chances of cheap power being available for agricultural pumping, it should be possible to look after irrigation requirement of the area lying to the east of the commands of Mayurakshi and DVC Projects. As the irrigation requirement is only occasional, groundwater pumping stands good chance of being economically feasible. Also tracts in the upland areas of Bankura and Burdwan have been clamouring for irrigation arrangement. These areas generally form the catchment of the major schemes which harness their run-off for use on irrigation of areas situated lower down. For these upland areas, scattered small works are likely to be popular. In their design, care will have to be taken to take up only storage works that would not deplete the run-off projected on the major scheme lower down.

(c) The present practice of insisting on an initial deposit of 50% of the pumpset cost is rather deterrent. Not many cultivators are able to muster up these finances nor (are they able) to pay the balance within a year of taking over of the pumpset. In other States, payment of the pumpset price is permitted in easy four or five instalments. If the State is able to relax the present mode of payment, use of pumpsets would be greatly encouraged.

(d) In Murshidabad District, the eastern boundary of Mayurakshi Project does not end at the Bhagirath River. A liner tract running north-south is left along Bhagirath River which is too high for irrigation from Mayurakshi. For irrigation relief to this area, it may be advisable to look into the possibility of installing pumpsets on the river at suitable points.

(4) RECOMMENDATIONS

(a) Construction of water channels has not been a popular practice with the cultivators in the State. The predominant crop of paddy is usually cultivated in a compact block and the cultivators convey irrigation water by surplusing it from one field to another. They have been able to persist in this practice, because not much cultivation is done in winter. For the conveyance of irrigation water to scattered rabi cultivation and also for economy in water use, it would be desirable to construct water courses.

(b) In the Nadia District and part of 24-Parganas District, it should be possible for the State to consider the location of a system of large size irrigation tubewells. Sites for the tubewells will have to be properly selected, so that they are powered by the construction of economical lengths of transmission lines. Also they should be situated centrally, so that the radiating water channels have not to be carried in heavy embankment, because of flat area that would be commanded by the tubewells.

REPORT OF THE MINOR IRRIGATION COMMITTEE ON TRAVANCORE-COCHIN

(1) OUTSTANDING FEATURES.

(1) A high percentage of the State, particularly the northern portion, is served by two monsoons. The rainfall, however, gets scare in the Southern part of the State. Small tanks are, therefore, in abundance in the south. In the northern part, rainfall intensity from the two monsoons is usually sufficient. Sometimes, however, the distribution is not favourable for the cultivation of two crops of paddy. It is for this reason that quite a large number of tanks have been in existence for storing water that is diverted from storage when they have plentiful supplies.

(ii) For irrigation to areas cultivated along the slopes of the hills, diversion schemes have been popular. Small tanks are only necessary in the lower regions between the foot of the hills and the coastal area. A few tanks are sometimes come across even in the coastal regions.

(iii) Tanks which have an ayacut of less than 200 acres are being tackled by the Panchayat Department of the State which is equipped with engineering staff comprising of a Senior Executive Engineer, two Executive Engineers, 11 Assistant Engineers with adequate subordinate technical staff. Tanks with bigger irrigation capability are entrusted to the P.W.D.

(2) IRRIGATION PERFORMANCE.

(i) A large number of tanks were in derelict condition when the GMF work was started in 1948. About 25 per cent. of the tanks have since been tackled. The restoration work carried out to these tanks comprises generally of desilting. In addition, provision of improved arrangement for surplusing and regulation is felt necessary.

(ii) According to the State Panchayat Act, the responsibility for the maintenance of these tanks rests with the Panchayats. Sufficient funds are not, however, available with most of the Panchayats for carrying out the repairs.

(iii) The Experience of the Panchayat Department has so far been that once a tank is repaired, it is not normally tackled again for a period of five years provided these tanks are situated in the midland area.

Tanks situated in the plains generally require special repairs after ten years. The Engineering authorities have been trying to enforce the Panchayats to carry out the normal repairs.

(iv) Silting of tanks in the State is a common feature. Desilting operations, as distinct from raining the bunds, are more popular in the State. This is explained to be due to the fact that basides inflow from the catchment, tanks are also fed from the springs. The discharge from the springs is greatly reduced if proper desilting is not done.

(v) Two paddy crops are raised in the area commended by the tanks; the first crop lasts from May to September and the second from October to January. A third paddy crop can also be raised in areas of punja cultivation. This crop is cultivated between December and April. In these areas, however, only third crop of paddy can be raised because during the rest of the year, the whole area will be submerged.

(vi) The work of desilting is mainly for strengthening bunds. In rare cases it is also resorted to for increasing the capacity of the tank.

(vii) The staff employed on small works is on the following basis:—

(a) Rs. 1 lakhs expenditure by a Supervisor. Normally the Supervisor is entrusted works worth Rs. 2 lakhs, but in the case of small tanks which are more numerous, this financial limit has been reduced to Rs. 1 lakhs instead of Rs. 2 lakhs.

(b) Every Executive Engineer is posted for two districts and has 4-6 Assistant Engineers.

Usually, the Superviors and the Assistant Engineers are capable enough to deal with the technical work that is normally involved on small tanks. The Executive Engineer is responsible mainly for making payments and according technical sanctions for works costing more than Rs. 2,000.

(viii) The problem in this State is not consistently that of irrigation. In the month of November, intensive arrangements have to be made for expeditious removal of excess water. This involves quick construction of earth bund and installation of suitable capacity of drainage pump that can remove the excess water from the paddy field. The punja Officer in the Agriculture Department is responsible for the supply of pumping sets.

(d) IRRIGATION POSSIBILITIES.

(i) The minor irrigation schemes so far in vogue are not likely to overlap with the catchment of any major valley storage project that is later projected. There may, however, be some duplication in the area meant for irrigation. But here again the tanks could be utilised for subsidiary storage.

(ii) There are no separate water rates on works that irrigate 200 acres or more but are not classed among major schemes. There is proposal now to charge Rs. 3-8-0 per acre on such medium works on the analogy of minor works. (The State has since passed the Irrigation Act, of 1956).

(iii) Availability of small quantities of sub-surface water is reported at several places in the coastal area. The sub-surface supplies are, however, not adequate nor are they available in sufficient compact areas for the launching of a State tubewell irrigation scheme. Exploratory drilling is proposed under the All-India Groundwater Exploration Project. Groundwater use may have to be restricted to places which are not too close to the sea to avoid intrusion of brackish water.

(4) RECOMMENDATIONS.

(i) Under the new Irrigation Bill, it is proposed to levy irrigation cess of Rs. 3-8-0 per acre on the areas that benefit from minor irrigation schemes. All the revenue that would accrue from this assessment will be credited to Government account. To induce proper maintenance of the tanks through the Panchayats, it is considered advisable that a portion of the assessment may be credited as "Irrigation Fund" that could be operated by the Panchayats exclusively for maintenance purposes of the minor irrigation schemes in the area.

(ii) The Panchayats Act, authorises legal action for negligence on tanks repairs. Active steps may be taken to enforce this provision. So far, not many cases came to notice where legal action has been taken against negligence of tank repairs.

(iii) Separate Executive Engineers are at present being employed under the Panchayat Department. It is for consideration if their functions cannot, be performed by the Executive Engineer incharge of normal public works in the area. This would economise on the present practice of a wholetime Executive Engineer for panchayat works. Payments for completed works could possibily then be handled by the Revenue Officer of equivalent status.

(iv) No standards have been drawn for proper maintenance of different types of minor irrigation works. On the analogy of what has been done for similar works in Madras, the State may undertake to draw out these standards for their enforcement of correct maintenance.

REPORT OF THE MINOR IRRIGATION COMMITTEE
ON
KUTCH

(1) OUTSTANDING FEATURES.

Kutch has a central plateau running east-west with an average elevation of 600–700 feet. The highest peak is around 1,400 feet above sea level. Besides the central range, a smaller range of hills run both to the south and north. Streams coming out of the central range pass across the south and north ranges through gorges before they appear in the coastal plane. These gorges with a wide basin on the upstreams site provide ideal sites for storage reservoirs. The bed slope of the southerly rivers is more gradual than those flowing to the north.

Annual rainfall in Kutch has nowhere been observed more than 12" The eastern portion, however, records a higher rainfall than the western one. The rainfall distribution is rather erratic. Frequent cloudbursts have been responsible for occasional high rainfall intensity.

The predominant soil is light in texture. The sub-strata comprises mainly of Deccan trap.

(2) IRRIGATION PERFORMANCE

Construction of 22 small storage tanks was tackled in the First Plan by the State Engineering Department for availing of the run-off from a total catchment area of 323 sq. miles. Besides this, a large number of small tanks were completed by the people who are conscious of the importance of stored water. The Revenue Administration in the State has been advancing loans from the GMF funds to the extent of Rs. 200 per acre of irrigable area. Such co-operative construction of tanks and canals has been limited to the storages that can be completed at a cost of Rs. 1 lakh. The Department under the Principal Engineering Officer of the State is responsible for the construction of tanks costing between Rs. 1 & 10 lakhs. The cost of small storage schemes completed by the Principal Engineering Officer has averaged between Rs. 250—350 per acre. While the *ad-hoc* land revenue under unirrigated area is between Rs. 1/8 & 2/8 per acre, the land revenue for irrigated area on the newly constructed tanks varies from Rs. 8 to Rs. 25 per acre. In addition to the land revenue, the irrigator has to pay the water charges every time he takes water from tank that has been completed and is being maintained by Government. These water charges are around Rs. 3/4/- per acre per watering. So far, no betterment levy has been imposed.

Besides irrigation from the storage tanks, quite appreciable irrigation relief has been brought about by the construction of wells. Sub-surface water is available in quite satisfactory quantities in the jurassic formations. Wells have been increasingly constructed in such formations. Boring have also been attempted with satisfactory results. On most of the bored wells, pumping sets have been installed. In absence of hydro-electric power, all the installed pumps have to be run by diesel engine.

(3) PROSPECTS

Cultivated patches lying between the central and the outer range of hills have, of late, been coming up with demand for tank construction that would look after irrigation requirement of their agriculture. Any indiscriminate construction of such tanks is likely to interfere with the run-off supplies to major tanks that would invariably be taken up on the eminently suited gorges where from the streams debouch to both north and south. There would thus appear a need for long-range plan being prepared for all likely medium and major schemes. Once this is done, smaller tanks can be proposed for places where they would not interfere with the run-off to the bigger tanks. With this care being taken on specific proposals of major water storage, there is a good scope for continued construction of minor irrigation works for the special needs of small patches of scattered cultivation that dot all over the State. Minor irrigation work has the advantage of meeting the irrigation requirement of small patches without heavy expenditure on long length of water conveyance and consequent construction of several cross drainage works. Likely evaporation loss can be minimized on minor tanks by carefully selecting such sites that are deep and narrow and do not propose an extensive water-spread. Present indications are that 50 water storage schemes—not costing more than Rs. 10,00,000 can be projected for storing the run-off from about 1,000 sq. miles of catchment area. These schemes would need careful survey and good technical supervision during construction; hence will have to be handled right from the start by the Engineering Set-up in the State. Alongside these constructions, there are good possibilities of irrigation benefit being extended by the continuation of present scheme of subsidizing tank construction. It should be possible for such tanks to make use of run-off from some 400 sq. miles of catchment area.

(4) RECOMMENDATIONS

(a) *Technical*

(i) The jurassic formations in good portions of the underground strata held out prospects for satisfactory groundwater supplies. Such areas have however to be carefully delineated. Geological investigations previously done need be compiled and future examination planned for marking out all ground-water-worthy areas. Activities projected under the All-India Groundwater Exploration Project may also be co-ordinated. It is very important that prospects of groundwater utilisation are completely explored. During the hot months after March, the evaporation from surface storages is so marked that for increasing irrigation benefit it would be safer to depend upon groundwater. It may be occasionally necessary to specially design the surface water storages for the additional purpose of recharging ground water.

(ii) In the design of the tanks, care is being taken for providing adequate surplusing capacity for even the occasional cloud-bursts. The outfall for such overflows needs, however, improvement. A gradual disposal would avoid scour and retrogration.

(iii) Chances of silting fast curtailing the storage capacity of the tanks are rather pronounced. While care is being taken of the catchment area by leaving an uncultivated reserve belt of land, additional storage capacity need also be provided in the initial design of the tanks.

(iv) For increasing use of groundwater, power facilities need be improved. There does not appear any prospect for hydro electric generation; hence alternative possibility of generating electricity at suitable places need be examined. At present, individual diesel-driven pumping sets are being used. If however, a compact groundwater-worthy tract is defined, it may be possible to arrange a central generating station that would supply electricity for a more intensified running of the pumpsets.

सत्यमेव जयते

(b) *Organisational.*

(i) As earlier mentioned, the scheme of getting tanks constructed through cultivators by advancing loans upto Rs. 200 per acre of irrigable area has been quite popular in the State. As the most outstanding sites must have already been made use of, future proposals would require a careful scrutiny. It is suggested that the design for all projected construction of tanks should meet with the approval of an Engineer before financing such constructions. Further it is necessary that all the promised commanded area that is initially forecast as irrigable should be assessed by Revenue Department at enhanced land revenue applicable to irrigated fields.

(ii) Cultivators may come up, in increasing numbers, for assistance in boring on their existing wells. This should be encouraged in all areas that hold out good groundwater prospects. Besides offering finances for boring work, the Administration should also arrange technical assistance by making available to the cultivators drilling equipment and expert advice. For satisfactory technical assistance, it may be necessary to set up a Boring Unit which may be staffed with Experts in Drilling and groundwater geology.

(iii) Definite procedure has been laid and is practised for proper maintenance of tanks that are completed by the Principal Engineering Officer of the State. The maintenance of smaller tanks that are completed through local participation is not perperly assured. It may be necessary to introduce legislation that would entitle Government undertaking the maintenance of such tanks that are neglected by the owners.

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REPORT OF THE MINOR IRRIGATION COMMITTEE ON EARSTWHILE BHOPAL STATE.

(1) OUTSTANDING FEATURES

Bhopal is a small State with a total geographical area of 44,02,000 acres situated in the north of the Central Platue at an elevation of 1,800 ft. The State is traversed with off-shoots of the Vindhian system and has an undulating topography.

The average normal precipitation is about 50″ in the year. The maximum precipation is generally confined to the months of July and August, though rainfall of the order of 9″ to 10″ is even observed in the month of September. October rainfall averages to about 1·5″.

The State is traversed by numerous small streams. They originate from local hills and are flashy in nature that is, they have sufficient discharge while the rains last but thereafter the discharge sharply declines. The small streams give rise to five chief streams namely the Betwa, the Bina, the Kular, the Burna and the Tandoni. The latter three streams are the tributaries of Narbada River which forms the southern boundary of the State. Parbati Nadi which is a tributary of river Chaubal forms the western boundary of the State. The two streams Betwa and Bina combine together and flow into River Yamuna, in the north.

Leaving a portion of the Parbati valley which is a alluvial, the soil in the State is medium black of trap and gneissic origin.

(2) IRRIGATION PERFORMANCE.

(i) *Progress*

From the point of view of irrigation development, the State has been backward in as much as only about 10 per cent. of the net area sown had been receiving irrigation supplies in the pre-Plan period. The bulk of this irrigation benefit, comprising about 60 to 70 per cent. of the total, had been provided by open wells alone and the rest by canals and tanks.

The Minor Irrigation Works such as construction and repairs of wells, construction and repairs of tanks and lift irrigation schemes on streams etc. carried out in the State during the First Five Year Plan, contributed to an increase in the irrigation potential of the State by about 50,000 acres.

(ii) *Open wells.*

A total of about 1,400 wells had been tackled in the State during the First Five Year Plan. The average cost per-wells worked out to Rs. 500 to 600 on the average. The cost was low because most of the wells tackled were old one that had been repaired. The construction of new pucca wells in Bhopal is actually expensive because firstly, rock is encountered at a small depth and secondly the soil is generally black cotton which does not permit direct sinking of masonry stoining. This expensive construction of pucca wells accounts for the tendency in the State to make wells of larger diam. and leave them unlined wherever the soil is firm and the underlaying is at a small depth. Such wells are reported to have worked satisfactorily in the State for the last many decades.

The pucca wells in the State have also comparatively large diam.; the latter ensures tapping of adequate number of fissures in the rocky substratum, facilitates blasting of the rocks and provides additional storage.

(iii) *Lifting water.*

The appliance generally used in the State for lifting water from the wells is Moht (Charas). In Sehore District where ground water conditions are more favourable for well irrigation, use of improved lift irrigation devices such as Persian Wheels and pumps had also been attempted.

(iv) *Tubewells.*

Four experimental borings had been attempted in the Narbada Region of Bhopal State which comprises alluvial soil. Two of these borings were reported to be successful with a discharge of about 20,000 gallons per hour.

(v) *Surface Water Utilisation*

In addition to construction of number of small tanks which conserve surface water for irrigation purposes, attempts had also been made here and there is in the past by the individual farmers to tap a little perennial supply in some streams by means of putting kutcha bunds across the streams and lift the impounded water, therefore, for irrigation. These bunds used to be washed away during the floods and had to be built anew after the monsoons. Some of these bunds were replaced by permanent masonry barrages during the First Five Year Plan and water was lifted therefrom by means of the power pumps. These installations had so far to be run with diesel engines. The pumped water has therefore been rather costly.

(vi) *Development of Irrigation Benefit*

The development of irrigation benefits in the State has been extremly slow on the Gravity Flow Storage Schemes as well as on the Lift Irrigation Schemes. This slow development was attributed by the State authorities to the following two reasons:—

(a) The cultivators of Bhopal have not been much irrigation-minded and there has not been much tendency to intensify agriculture on improved lines.

(b) The present irrigation rates were considered a bit too high to induce the cultivators to undertake irrigation enthusiastically. Bhopal Estimates Committee has made recommendations to reduce irigation rates in order to increase the use of irrigation. (Irrigation rates in Bhopal are of the order of about Rs. 30 per acre for sugarcane. The rates are double for lift irrigation schemes).

In spite of these rates being of quite substantial amounts, the Lift Irrigation Schemes in the State were reported to be unproductive; even the operational cost was not covered in some case. This has particularly been due to the fact that actual irrigation materialised on the completed projects is yet far below the total irrigation potential.

(vii) *Responsibility for Construction & Maintenance.*

The prevailing practice has been that new works costing more than Rs. 10,000 are carried out by the PWD and works of smaller amounts than this are carried by the Revenue Department.

The maintenance of tanks with irrigation capabilities of more than 300 acres are being looked after by the PWD and the small tanks are maintained by the Revenue Department.

Development of lift irrigation from the wells, of course, is on private initiative, though Government help by way of technical guidance and by sanction of subsidy and loans, is given. Lift Irrigation from streams is, however, being undertaken by the PWD as a state enterprise.

(viii) *Assessment of Irrigation Benefits.*

The PWD assess the actual irrigation done on each new and old scheme under its charge. The irrigation rate is assessed on the basis of the crop that matures.

There is, however, no regular measurement of benefits on other Minor Irrigation Works such as wells or the tanks under the charge of the Revenue Department. Such benefits are only accounted for during the normal duties of the Revenue Staff in connection with recording different crops grown in the area under their charge. The State moreover, has no instrument to enhance the land-revenue on the improved irrigated areas from such works till the next settlement takes place.

(3) PROSPECTS.

Chances for increasing use of ground water for irrigation are rather not very promising in the State. Sufficient soil cover for adequate water storage is not available due to presence of rocky substratum at a small depth. Ground water availability in wells, is therefore, limited to the presence of fissures and cracks in the rocks. Due to favourable strata conditions, prospects for construction of wells are better in Sehore District, than other parts of the State.

The supply of well is generally not likely to be copious enough to justify and warrant the increasing use of pumps and even Persian Wheels. The use of power pumps will only justify if the beneficiaries are able to organise themselves in co-operatives so that the pump is put to maximum use. A pump with an individual cultivator, is not likely to be used for more than 4 hours at a stretch in the working season even in regions with favourable ground water availability.

While a few small tubewells may be successful here and there in the alluvial river basins, it is not likely that the compact block could be delineated where economic operation of tubewells could be achieved through installation of a sufficient large number.

As far as the surface water irrigation from the diversion works alone is concerned, it may not be possible to construct gravity flow irrigation channels in the large measure for two-fold reasons. Firstly, perennial discharge will be scanty unless sufficient catchment is harnessed and secondly, the nallahs and tributaries, in the comparatively flat region of cultivable lands, are generally deep set and cannot, therefore, command gravity irrigation. Increasing use can be made of lift irrigation scheme on streams but experience has shown that such schemes are likely to be very expensive unless Hydro-Electric supply is available and cultivators have become irrigation-minded. The state does expect to get some hydro-electric power on completion of the Chambal project.

The undulating topography of the State, especially near the foot of the hills offers an ample scope for irrigation development through surface water storage Scheme. The PWD of the State has already in view some 30 probable sites for location of storage works in the different valleys of the State. Besides, there are about 500 to 700 old tanks with capabilities ranging from 10 acres to more than 500 acres, which are reported to be still lying in a state of disrepair; irrigation could be developed at a more economical cost by carrying out expeditious restoration of these tanks.

(4) RECOMMENDATIONS.

(a) *Technical.*

As chances for wide spread ground water utilisation in the State are remote, it becomes important that further construction of wells, as also of the distribution of improved lifting devices, should be adequately controlled to avoid indiscriminate use and over-with-drawal. The use of power pumps should only be encouraged in the area where ground water availability is more favourable and beneficiaries are organised to share the benefits. Alongside new construction, possibility of increasing ground water supply in existing wells by means of boring and deepening should be explored for adoption on a large scale.

In view of their high operational cost, it will be desirable that implementation of state lift irrigation schemes is deferred until cheap electric power is available in the State. Meanwhile, preference and priority should be given to storage works which are capable of gravity flow irrigation. Alongside new construction, proper attention also needs to be paid to the restoration of old works which are in a state of disrepair. The restoration work should be organised on a systematic basis, phasing the programme according to priority of taking up more economic schemes earlier.

The foremost objective that should occupy the attention of the State authorities as regards irrigation development, planning of such measures that would make the cultivators conscious of irrigation advantages. Unless it is achived by taking adequate measures such as propaganda, extension programmes and adjustment of irrigation rates, it will not be possible to bring about quick development of irrigation benefits on the complete works.

If irrigation rates, comparatively higher as they are at present, were reduced slightly and a compulsory irrigation cess was levied on all the commanded area originally forecast under the projects, it would provide more incentive to cultivators for making increasing use of irrigation water.

(b) *Organisational.*

As the cultivators come up in increasing number with requirement for new wells and imporvement on existing wells, it will be desirable that the State Departments which are responsible for sanction of financial assistance for such works should also arrange necessary technical guidance and supervision in an increasing measures. The administration could also encourage boring and deepening of wells by making available to the cultivators drilling equipment and expert advice. Suggestion for setting up a departmental boring unit that may be adequately staffed, should also be considered. Such a unit could be organised on no-profit no loss basis, recovering expenditure from beneficiaries in gradual instalments.

After completion of new works or restoration of old works, it is important that adequate administrative measures are undertaken to safeguard their sustained maintenance. While the maintenance of works under the charge of the PWD is sufficiently assured, there is no proper agency made responsible for the maintenance of small works which are completed through local body's participation and on which no irrigation cess or rates are levied. The maintenance of these works could be entrusted to village panchayats or other co-operatives who could be permitted to levy a small irrigation cess for raising the necessary funds for maintenance. In cases of continued neglect, PWD should be authorised to undertake the repairs and recover the cost incurred thereon from panchayats.

As the maintenance of works under the PWD is more assured, it is for consideration if the responsibility of PWD for maintenance of tanks be not enlarged to new tanks with irrigation capability of even less than 300 acres. In Madras and Andhra, PWD looks after the maintenance of tanks with irrigation capability of 200 acres.

In order to exercise a check on proper maintenance it will be desirable that all the existing and completed works are properly registered and thereafter progressive information regularly collected of the behaviour of such works.

To ensure proper standards of construction and maintenance, the PWD of the State could lay down certain specific standards of construction and maintenance of tanks. These standards would be of particular assistance to other Departments of the State taking up construction and maintenance. In addition, the latter departments should also avail of, in an increasing measures, technical guidance and supervision of the PWD of the State wherever such assistance is called for.

REPORT OF THE MINOR IRRIGATION COMMITTEE ON THE ERSTWHILE AJMER STATE

Ajmer is a small State located in the heart of the State of Rajasthan. It has a total geographical area of 15,27,000 acres. Elevation varies from 1,000 to 2,000 ft. above sea level. The topography is hilly. A part of the Aravalli range extends across the State from north-east to south-west and form what is known as "Ridge of India". Rainfall water that falls on the eastern side of the ridge, drains in the Bay of Bengal while that which falls on the West side drains towards the Arabian Sea.

The monsoon period starts in late June or July and usually ends in September. The average rainfall is 20·8″; the lowest record has been 5:8″ in 1918-19 and the highest 48:3″ in 1917-18. The climate is dry. The temperature varies between 35.F in January and 112.F in June.

The State has no perennial river. The hilly catchment gives rise to several streams which quickly drain away the water outside the State. Due to recurrent failure of the monsoons, famines have occurred very frequently.

The soils and their depths vary in the State within a wide range. In Pushkar Region, the soils are sandy; the rock is met with at a depth of about 50 ft. below the ground level. In Ajmer Region, soils are sandy loam varying from pale yellow to brown in colour. They are comparatively hallow; the rock is found at a depth of about 8 to 10 ft. Outcrops are apparent in certain places. In Kheri Region, the soils are more clayey and are dark in colour. They are fairly deep; rock is met with at a depth of about 15 to 20 ft.

(1) IRRIGATION PERFORMANCE.

Water scarcity has been a real and serious problem in the State of Ajmer. Attempts had been made in the past to tackle the problem through construction of hundreds of tanks and large number of irrigation wells. As a result of these works, irrigation facilities had been provided to an area of about 1,05,000 acres, in the pre-plan period when the total area sown was of the order of 3,50,000 acres. Taking into account the arid condition of the State, this was a good achievement.

The tanks constructed for conserving rain water served two-fold purpose The water collected in these tanks was used firstly for direct gravity flow irrigation and secondly for recharge of the ground water reservoir. Though these works could not adequately meet the threat of the famine because the tanks did not fill in years when rainfall was low, yet they helped a great deal in causing water to be conserved for storage underground, wherefrom it could be used in lean years.

Check-Dams locally called "Rapats" had also been constructed at suitable sites in the past for conserving rain water and recharge of the ground water.

Efforts made in the First Five Year Plan resulted in construction of 5 more tanks, 24 Rapats, 24 Water Channels, repairs of 250 old Government tanks, sinking and deepening of 775 new wells, repairs and deepening of about 3,000 old wells and distribution of 20 Pumping Sets. These additional works contributed to an increase in irrigated area of about 25,000 acres.

The construction of repairs of Minor Irrigation Works where the entire expenditure is borne by Government has been the responsibility of C.P.W.D. Smaller works which made use of private contributions to a certain extent, have been sponsored under the Revenue Department. Generally speaking, works such as construction and repairs of tanks and linking of irrigation channels have been carried out by the C.P.W.D. whereas the works pertaining to construction and improvement of wells by the Revenue Department.

The taccavi loan granted to the agriculturists for construction or improvement of wells were generally restricted to a maximum of Rs. 1,800. The usual ratio of sharing of cost between the Government and the private agriculturists for such works is 2:1. Taccavi loans had been granted even in the old Istimrari areas (so far in the State, only about 1/3rd of the total area was under the Revenue Department while the remaining 2/3rd comprised Istimrari area). Proper account of the taccavi loans sanctioned and recoveries made from time to time onwards since 1951, has been maintained. Above 50 per cent. of the due recoveries after 1951 was reported to have been realised.

The State had so far been maintaining about 300 tanks on Government cost in the Revenue Department area. In addition to these 300 tanks, 600 tanks belonging to the Istimrari area have been taken over by the State only last year. All these tanks are in a state of disrepair. The repairs required are in the nature of (a) strengthening the banks; (b) making new surplusing weirs and (c) repairing or raising of existing weirs. In very many cases the tanks have gone into disuse because the feeder channels have disappeared and even the original catchment is not effective in feeding.

The regular annual budget for maintenance of 300 government tanks has been of the order of Rs. 3 lakhs which was sufficient to maintain them in a satisfactory condition. The maintenance cost worked out to approximately 2 per cent. of the total cost of the works. To ensure systematic and proper maintenance, important salient features in respect of these tanks had been registered in a Tank Book, the copies of which were maintained in different offices. A staff comprising four Overseers and other Senior Officers attended to the repairs of these tanks and any special complaints regarding their functioning.

While the C.P.W.D. had staff for the maintenance of the tanks, they did not have sufficient staff for maintenance of Rapats which also needed looking-after. Though the Panchayats Act had recently been passed in the State, yet the Panchayats seemed to take little interest in the maintenance of tanks and even of the Rapats. They had comparatively little incentive for any work which did not exclusively belong to their own village.

As far as development of benefits in the State was concerned, irrigation on wells and also the direct irrigation from the tanks developed almost immediately on the completion of the works. On the contrary, the benefit of replenishment of ground water, as a consequence of the construction of tanks or the Rapat, took about 3 to 4 years to accrue after the completion of the work.

For levy of irrigation tax on the benefits accrued from the tanks, the latter have been divided in four classes according to their irrigation capability, soil conditions and other factors such as responsibility for maintenance etc. The irrigation rates charged are different for different classes of tanks. For first class tank, the irrigation rate is levied crop-wise and on the area basis. For the fourth class of tank, the land rent rate is supposed to account for the irrigation benefit and no separate irrigation rate is, therefore, levied. The irrigation rates for the other two categories are uniform as far as harvest is concerned but vary for each individual tank or for groups of tanks; in latter case, the rate is the same for all tanks which lie in an assessment circle and form one group.

(2) PROSPECTS.

In an attempt to relieve the water scarcity in the State, the programme of construction of wells has reached an optimum stage, where further construction may require judicious planning and an accurate appraisal of available ground water resources. While there may be still some possibility of construction more wells in the Pushkar Region (an area of about 200 sq. miles) which experiences the heaviest rainfall in the State, construction of more wells in other areas is more likely to run the risk of over withdrawal of ground water in excess of replenishment.

Prospects for tapping any appreciable quantities of unused ground water through tubewells are very remote. Whatever alluvial basins exist in the State they have relatively thin fill over the bed rock. They therefore, depend entirely on the local rainfall for recharge. Any excessive quantity of pumping is thus likely to deplete the supply very quickly. Besides, there would be risk of the supplies being affected adversely in the existing open wells in the vicinity of any large scale pumping.

Deepening of wells for augmenting water supply in the open wells will continue to be popular. Ground water recharge, however, being limited, scope for this programme will not be unrestricted. With the development of cheap electric power and over all economy in the State, improved water lifting devices will gradually come in vogue.

Prospects for any surface water utilisation by means of diversion works alone are practically negligible. All the streams traversing the State originate locally and it is not possible to have any diverted perennial channels from these streams. As mentioned earlier, the ground water supplies in the State also depend entirely on the local rainfall. A programme of construction of tanks and rapats tapping and conserving rainfall water that would otherwise be lost as run-off, would, therefore, be fundamentally sound and provide the only practical solution for alleviating the water scarcity.

The numerious tanks have already been constructed in the past and there is a possibility for constructing more tanks. Alongside new construction, sustained maintenance and restoration of the existing tanks warrants even a higher priority and is also likely to deliver the goods immediately at a more economical cost. The scope for such restoration works is outstanding in the case of 600 Istimrary Tanks that have been recently taken over.

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Reckoning on the renovation works so far estimated (35 tanks at the cost of Rs. 5 lakhs), it is likely that heavy financial allocations will be required for tackling all the 600 Istimrary Tanks.

Construction of sub-surface dams especially in region of light soil, will have amples scope as a scarcity measure for replenishment of ground water supply. Though these works may not yield any direct irrigation, yet their usefulness will be great against famine and drought conditions.

(3) RECOMMENDATIONS.

(a) *Technical.*

As increasing reliance is placed on ground water development for sustained irrigation even in drought years, it will be important to undertake a systematic and comprehensive study of the ground water conditions. Such study should be aimed to throw light on the ground water recharge and out-flow conditions and enable reliable estimate to be formed of the ground water storage possibilities. Future construction of wells and even the improvement on the existing wells should judiciously controlled and planned so that the total withdrawal of ground water is kept in balance with the total recharge. Once this balance has been attained in a particular basin, further construction of wells will be superfluous and uneconomical.

Improvement in the design of tanks and other engineering structures could be effected by collecting and sifting sufficient hydrological data regarding rainfall, run-off-floods and losses from evaporation and seepage. It would be advisable to arrange for installation of additional observation and recording stations and also proper recording of observations on the existing works.

The programme for restoration of derelict tanks should be properly phased, according priority in order of low cost-benefit ration and easy organisational facilities afforded for construction. While carrying out restoration works, it is important that salient points of the design such as live and dead storage of the tanks the capacity of the surplusing arrangement and the irrigation requirements should be carefully rechecked and adjusted according to the up-to-date knowledge and past experience of performance. The cases where a part of the capacity has been lost due to silting it will be more feasible to raise and strengthen the tanks rather than carrying out expensive item of desilting. Diversion of neighbouring catchments and deepening of feeder channels will also greatly help the restoration of quite many a tanks.

Although lining of distributary channels, off-taking from the tanks will reduce percolation losses yet the saving in water may not justify the increase in the initial cost and also of maintenance. The maintenance and repairs to lined portion will require more skilled labour and supervision which may be beyond the scope of private agriculturists. It will be more feasible at this stage to line the main distributary channel a few hundred feet just down-stream of the off-take from the bank and leaving the rest of the distribution system as unlined. Lining of the other channels could be taken up later when the agricultural economy of the State had sufficiently developed.

In the design of rapats it is important that their flanks should be properly tackled and guarded against breaching during the floods, as otherwise the safety of the rapats themselves will be in danger.

(b) *Organisational.*

While the responsibility for maintenance of small Lift Irrigation Works such as wells etc. rests with the individual agricultrists, there is no properly organised agency for looking after the maintenance of other Community Works such as the rapats and small tanks etc. The PWD is not sufficiently staffed to look after the maintenance of these small works. To avoid risk of these works getting soon into the state of disrepair or disuse altogether, it is desirable that village panchayats should be entrusted with the maintenance of these works at the earliest. These Panchayats could be properly organised and educated for rising to the occasion. The PWD could be asked to draw proper standard and prescribe important rules and specifications which may guide the panchayats in efficient up-keep of the works. The local officers of the PWD could carry out periodical check on these works. In cases of continued neglect, PWD could be authorised to undertake the repairs and recover the cost incurred thereon from the Panchayats.

The work of deepening of wells is at present tackled on receipts of individual applications. This naturally results in an increase of overheads by way of increased transport and idling of the compressor units. If work in each locality could be organised to be taken up in one lot, more economical and expeditious turn-out may be expected.

In respect of levy of irrigation tax, it does not appear desirable in a dry state like Ajmer to impose a compulsory irrigation cess on the entire area commanded. The water requirement is so compelling that proper and expeditious utilisation of irrigation water will take place inevitably. On small scattered works, the Panchayats could be permitted to recover the water cess which may be sufficient to meet the maintenance expenditure other than that contributed by the agriculturists in the form of voluntary efforts.

For balanced economic development and equitable distribution of benefits, proper measures need be adopted for estimating the indirect irrigating benefit that accrues from rapats and tanks by way of replenishment of ground water. This benefit could thereafter be properly accounted for by enhancing the land revenue by the requisite amount at the earliest or at the time of next settlement at the latest.

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